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## ENGLISH TELEPHONE PATENTS.

THE appeal in the case of the United Telephone Company *v.* Bassano and Slater has been heard and dismissed. As our readers will remember, the appeal was made by the defendants from the decision of Mr. Justice North, who held that the instrument made and sold by them possessed the essential elements of the telephone described in Edison's patent of July 30th, 1877, those elements being a diaphragm capable of vibrating in response to the sound waves created by the human voice, and tension regulators having the purpose of increasing or diminishing the intensity of the electric current. Edison plainly described a diaphragm of definite form, and indicated its position in his instrument. In the Bassano telephone nothing corresponding to Edison's description and illustration of a diaphragm is to be found; but the tension regulators (which also differ from the tension regulators of Edison) and other portions *were* enclosed within a framework of wood, and for an obvious purpose a mouthpiece, also of wood, was attached to the framework. Now, wood, as well as most other things, as everyone knows, is capable of vibration to a certain degree; and this fact the plaintiff company and its advisers seized upon to preserve the monopoly they have secured. The wooden framework and mouthpiece, said they, are diaphragms, receiving motion from the air waves set up by the voice and communicating them to the tension regulators, thus serving the very purpose for which Edison devised his smaller diaphragm. Mr. Justice North held their view to be the correct one, and the defendants appealed against his decision. Lords Justices Cotton, Lindley, and Lopes have now confirmed their learned brother's judgment, upon the ground that, according to Lord Justice Fry's definition of the word, viz.: "something which separates something from something else," there is clearly a diaphragm in the defendants' instrument; and, secondarily, that tension regulators substantially similar to the tension regulators of Edison were also present.

Upon these grounds it is obvious that it will be perfectly futile for any inventor to hope to devise a telephone transmitter which is to act by the impact of sound waves upon tension regulators, for it will be impossible to bring about this effect without the intervention of a (legal) diaphragm. Messrs. Bassano and Slater state that they can work their telephone whilst omitting altogether the wooden back alleged to be the diaphragm. The Court declined to say whether the instrument would still be an infringement; but clearly, if Mr. Justice Fry's definition is to be abided by, it would be. For the air itself, the plaintiffs would next contend, is a diaphragm: it intervenes between the speaker's lips and the tension regulators—in other words is something separating something from something else!

How long are these sophistical definitions to stand? When will a judge throw to the winds the shifting and evasive assertions of partisan scientists, who quibble over gnat-like niceties, and, when it suits their purpose, complacently close their eyes whilst a whole camel is gulped down? No doubt the learned ones of the bench always seek to give righteous judgments, but in their straining to be scientifically precise they sometimes overlook the claims of common sense.

## PRIMARY BATTERIES.

LAST week we devoted no inconsiderable portion of our space to a very complete description of the new primary battery devised by Mr. Upward.

The question of cost naturally forms a most important item in primary battery installations, and the figures we gave in our last issue are doubtless much nearer the mark than those claimed for other types of battery, because they have been compiled from a really practical installation, which has been in operation for a considerable period.

It is said that with the Upward battery we may obtain a lamp of 10 candle-power at an expense of one halfpenny per hour, allowing for losses in the accumulators, &c., and we do not know of any previous instance where such economy has been obtained with galvanic elements even when working direct.

Mr. Sidney F. Walker in a communication addressed to us last week, takes exception to the Upward battery, and even goes so far as to express the opinion that the inventor has made a retrograde movement. He says: "His apparatus is too complicated; you have first your chlorine generator, then your primary battery, then your secondary battery," &c.

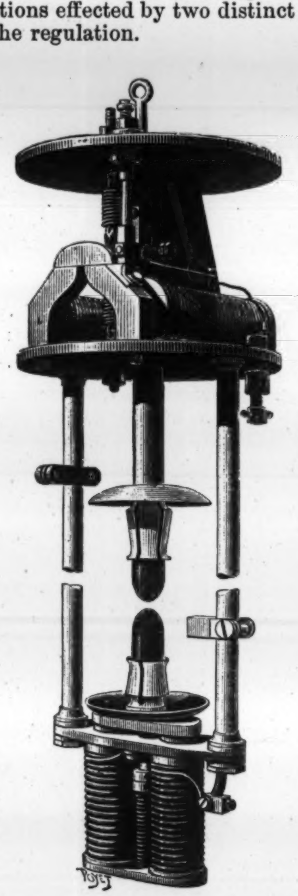
Just so! Mr. Upward's primary apparatus simply takes the place of the gas engine and dynamo of the orthodox household installation, and these two, we imagine, are as liable to become sources of failure as the chlorine apparatus and battery.

As to the first cost of the plant, the Upward system is by far the cheapest, and, as the most recent figures given by Mr. W. H. Preece respecting the working cost of the gas engine-dynamo-secondary battery plant in his private house can doubtless be relied upon, it would appear that this primary battery arrangement produces a result not so uneconomical after all, when compared with the method usually adopted for domestic electric lighting. Mr. Preece found that his domestic electric lighting cost just about twice the price of gas; and gas at Wimbledon is charged at the rate of 4s. 3d. per 1,000 cubic feet; Mr. Upward reckons that by his method electric lighting is possible at a price equivalent to gas at 8s. per thousand. Our readers can calculate for themselves the difference in the cost of the two systems, assuming, of course, that the figures given have been correctly ascertained.

We shall be pleased to learn that the Upward system is being practically applied to house lighting, for notwithstanding our own belief in its perfect adaptibility for the purpose, the favourable testimony of householders is the best argument with which adverse opinions can be met and refuted.

## PIEPER'S ELECTRIC ARC LAMP.

TO supply simultaneously from the same machine, arc lamps and incandescence lamps, without the lighting, extinction and regulation of the former acting upon the latter and affecting their steadiness, has been for several years a problem considered, if not insoluble, at least as offering serious practical difficulties. It has now been solved by several systems, and the Pieper arc lamp, shown in the accompanying figure, is an apparatus attaining most simply the object desired. These lamps are combined to work by derivations of two lamps in series with a machine of constant potential, giving, say, 100 volts at the terminals, and supplying at the same time incandescence lamps of the same potential. The novelty, ingenuity, and simplicity of the regulation consist in the mechanism that pushes forward the carbons. The working comprises two distinct operations effected by two distinct systems, the starting and the regulation.



The starting is effected by an electro-magnet of thick wire, which brings down the lower carbon until it is at a sufficient distance from the upper one for the lighting to be effected as soon as the current is sent through, keeping it in this position as long as the current is passing. A counteracting spring brings the lower carbon again into contact with the upper carbon as soon as the current ceases to pass through.

The regulation is performed by an electro-magnet of fine wire connected as a shunt to the terminals of the lamp; the two cores end in pole pieces, opposite which is an armature of soft iron mounted on a lever oscillating round a horizontal axis and raised by a counteracting spring. The movement of this armature has the effect of breaking the circuit of the fine wire and causing it to undergo a series of vibrations, like an ordinary electric bell. As long as the arc has its normal value, the difference of potential at the terminals is not sufficient to enable the attraction of the regulating electro-magnet to counterbalance the action of the opposing spring, and the armature remains drawn away by the action of this spring. As soon as the arc lengthens, the difference of potential increases, the armature is attracted and performs, under the influence of the interruptions of current, a certain number of vibrations. Each of these vibrations causes a slight advancement of the upper carbon holder bringing it almost imperceptibly nearer to the lower one, until the distance between them is sufficiently diminished to bring back the difference of potential to such a value as to make the action of the counteracting spring equal to that of the electro-magnet. The oscillatory movement of the armature has the effect of freeing the rod holding the carbon from the action of a brake which keeps it in position, whilst a steel spring presses obliquely on this rod and causes it to move slowly downwards; the armature then ceasing to be attracted, the steel spring moves back and the brake again applies itself to the rod, keeping it in this fresh position and so on.

The weight of the rod has nothing to do with the working, and the movement is produced by the vibrating electric apparatus, consisting of the electro-magnet and its interrupter. The mechanism occupies a very small space, and works with the greatest precision.

The same method is suitable for arcs of different power, according to the diameter of the carbons and their quality, from 4 to 10 ampères. Each lamp requires only 40 volts, the two lamps in series therefore only take 80 volts; if the machine produces 100 volts at the terminals, the resistance of the conductors connecting the lamps together and to the machine is calculated, so as to absorb the 20 volts in excess.

M. Pieper's regulator, which we (*La Nature*) saw working last year with the greatest regularity, at the International Exhibition at Antwerp, is employed with Cance lamps in installations of the Edison system.

## A CHRONOMETER WITH A MAGNETIC ESCAPEMENT.

THE apparatus which I (M. A. d'Arsonval) have the honour of laying before the Academy has been designed at the instigation of my master, Prof. Brown-Sequard, who wished, with my assistance, to resume his former experiments on the rate of the transmission of sensitive impressions through the spinal marrow in a normal or in a pathological condition. My distinguished master was, in fact, the first to show, in 1859, that a sensitive impression undergoes a considerable retardation in its passage through the spinal marrow.

Subsequently, a great number of physiologists (Helmholtz, Bast, Chauveau, Marey, Hermann, &c.) have measured with great precision the absolute speed of the nervous agent in the nerves. The procedure generally employed by physiologists, especially since the researches of Marey, is an application of the graphic method which owes so much to this author.

A smoked cylinder, moved by a Foucault regulator, receives two parallel traces; the one, which gives the time in hundredths or thousandths of a second, is a sinusoid traced by the vibrations of a diapason; the second trace, which marks the beginning and the end of the phenomenon, is given by a Marcel Deprez electro-magnetic signal or by the pen of Marey's lever-drum. This method is faultless as regards precision, but it requires a previous training and a series of operations which cannot be expected from an hospital surgeon and still less from a medical man in his private practice.

The apparatus which I am about to describe gives the time in tenths of a second like an ordinary chronometer, by the simple displacement of a needle on a scale, without employing the graphic method.

It is essentially composed of a piece of clockwork provided with a Foucault regulator which causes an axle ending in a small circular plate of 12 millimetres in diameter and covered with a thin sheet of caoutchouc, to make exactly two revolutions per minute.

Opposite this plate, and at the distance of one millimetre, there is a second plate of tinned iron of the same dimensions and parallel to the former.

This second plate terminates a small, very short axle carrying at its other end a thin aluminium wire at right angles to itself. This aluminium wire serves as a finger, and moves on a scale divided into 50 degrees.

An antagonistic spring constantly pushes the tin plate against the plate of the movable axle; under this pressure the two axles form one, and the aluminium needle turns round the scale with the speed of two revolutions per second.

A small electro-magnet is behind the tin plate, which serves it as a keeper.

If a current is directed into the electro-magnet the disc of tin is attracted, it becomes separated from the revolving plate and the aluminium finger is rendered motionless on the scale as long as the current passes. At the moment of the rupture of the circuit the antagonistic spring produces the escapement, and the finger sets off instantly at the speed of two revolutions per second. The extreme lightness of the pieces and the nature of the electro-magnet render the time lost similar to that in the electro-magnetic signal of M. Marcel Deprez.

The displacement of the finger on the scale measures the time during which the electric current is interrupted, in hundredths of a second.

Hence to measure the speed of an impression the arrangement required is most simple. The experimentalist touches the subject with a small manipulator consisting of a spring bearing upon a point. At the moment when contact with the skin takes place the spring abandons the point, the current is broken and the finger sets off from zero at the speed of two revolutions per second. The subject holds in his hand an electric stop upon which he presses as soon as he feels the impression. This pressure re-opens the current and consequently stops the finger by actuating the electro-magnet. The time which has elapsed between the moment of excitation and that of perception is thus found given in hundredths of a second by the movement of the finger on the divided scale. This little apparatus, very ingeniously constructed according to my indications by M. Ch. Verdin, is of minute dimensions; it is contained in a circular box of 20 cm. in diameter by 6 in thickness. Its small bulk and the ease of its use render it an essentially clinical apparatus, calculated in many cases to throw a light upon nervous pathology.

This, however, is not the limit of its utility; it is equally calculated to be of service in measuring phenomena of short duration, measurements which we are reluctant to undertake by the graphic method. M. Brown-Sequard will shortly lay before the Academy very interesting and novel results already obtained.

## THE ELECTRIC LIGHT ON THE SUEZ CANAL.

THE passage of the Suez Canal, which until recently occupied from 36 to 48 hours, can be made, now that navigation during the night is possible, states *Engineering*, in 16 hours for mail steamers and war vessels, fitted with the electric light apparatus and projectors prescribed by the Canal Company. This important advance is the result of a very interesting report by Commander Hector, of the steamer *Carthage*, belonging to the Peninsular and Oriental Company, and addressed to the directors. This report was written after the *Carthage* made the first continuous passage, under the authorisation of the Canal Company, given the 1st December, 1885. The *Carthage* arrived at Suez after a run from Port Said of 18 hours. The actual running time was 16 hours, there having been two delays caused by impediments in the channel; the mean speed made was 5·43 miles per hour. The passage as far as Ismailia was the most interesting, because it was the first attempt to take a large vessel through at night, with the aid of the electric light. On the arrival of the *Carthage* at Port Said, it prepared for its immediate entry into the canal, and its free passage to Ismailia. The start was arranged for 8 p.m., and a number of persons interested in the experiment went on board. The projector was placed forward and at a height of 16 feet above the water. Shortly before eight, the dynamo was started, and the circuit closed. As soon as the projector was illuminated it was evident that its position had been well selected, and that the power of the beam, as well as the amplitude of the luminous zone, were ample to insure the success of the experiment. The number of surrounding lights, and the presence of a steamer taking in coal by the light of torches, prevented those on board the *Carthage* from seeing the buoys placed at the entry of the canal. At eight o'clock the mooring ropes were cast off, and as soon as the steamer had passed the buoys, the entry of the canal could be seen. The entrance to the canal is on a curve which may easily cause a difficulty if the buoys are lost sight of. To prevent this, the first two had been previously lighted. It was evident, however, that this precaution was unnecessary, because the power of the projected beam was ample to enable the lookout to see the buoys. The moon did not rise till nine o'clock, so that during the first hour the run was made in darkness. As soon as the straight portion of the canal was reached, the value of the projector was evident, the amplitude of the beam being sufficient to illuminate the buoys on each side of the channel. Further on the banks of the canal, as well as the channel markings, were clearly visible; the effective range was then three-tenths of a mile, more than sufficient for the handling of the ship. The light colour of the banks, reflecting the beam from the ship, further assisted the illumination, and the influence of this reflection was especially noticeable along the high banks of the curves near Ismailia. This station was reached at 5.15 a.m., without any difficulty having been experienced during the journey, but with a delay two miles south of Ismailia. A dredger on the western side had neglected to show her lights, and the pilot was obliged to stop, and on again starting, although the dredger had been passed successfully, the ship had not recovered sufficient speed to take the curve of the canal. It was therefore necessary to stop again, and go astern. In this way an hour was lost, but the average speed made, allowing for this delay, was 5·09 miles per hour from Port Said. The practicability of passing through the canal by the aid of the electric light was thus demonstrated by this first experiment. The directing lights placed on the banks opposite each station served to direct the ship during the moments of extinction of the projector. It should be added that the conditions were very favourable for the success of the experiment; a clear air, brilliant moonlight after 9 p.m., and no wind. However, the captain in his report does not consider that the moonlight assisted in the success of the experiment, as during the first hour, when the night was quite dark, no difficulty was encountered, and the buoys marking the channel could be very clearly distinguished. It is quite unnecessary to enlarge on the advantages arising from the economy of from 18 to 26 hours without any serious increase in expense, but it will be of some interest to point out how the result was brought about.

After considerable investigation the Suez Canal Company established six fixed signal lights, supplied with petroleum, between Port Said and kilometre 54; these lights give the pilots their alignment in the straight sections. The company also prescribed, in certain regulations for the night transit, the conditions which the electric light apparatus must fulfil. Article 2 runs thus: "The commanders of vessels of war and mail steamers that are intended to be taken during the night from Port Said to kilometre 54, and *vice versâ*, must notify to the agents of the company at Port Said, Ismailia, or Port Tewfik, that they are provided with the following apparatus. 1. Forward: An electric projector with a range of 1,200 metres. 2. Aft: An electric light capable of illuminating a circular field of from 200 to 300 metres in diameter. 3. On each side an electric lamp and reflector."

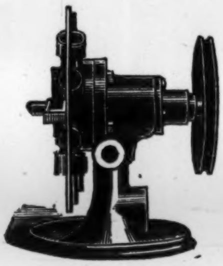
These conditions were laid down after a series of experiments made in the canal by the company, aided by M. Lemonnier, of the well-known firm of Sautter-Lemonnier and Co., Paris. These experiments demonstrated that the forward projector must have a high power, and give a beam suitable to the dimensions of the canal and the positions of the buoys; that it should be placed from three to four metres above the level of the water, beyond the view of the pilot; that the side and stern lamps should fulfil certain conditions, that they should be easily managed, and that their control should be under the hand of the pilot that he may light or extinguish any or all of them at will.

The foregoing conditions can be easily complied with on all ships fitted with electric light apparatus, and those vessels not so provided can, if they wish, follow the example of the Peninsular and Oriental Company, who have solved the problem for their fleet in the following manner. A complete plant, including dynamos and steam motor, switchboard, projectors, lamps, conductors, &c., is taken on board on entering the canal and discharged on leaving it. Suitable arrangements for making steam connection are of course provided on board. The work of taking this installation on board and discharging it is done very rapidly, so that no delay at either end of the canal is caused. After several trials with different apparatus, the Peninsular and Oriental Company have ordered some sets of apparatus from MM. Sautter, Lemonnier and Co. similar to that employed on the *Carthage*. The apparatus includes a compound Gramme dynamo, driven direct by a Brotherhood engine, both of them being on one bedplate, a Mangin projector with a planetic mirror, hand lamps, conductors, and switchboards, the whole being arranged very compactly for easy handling.

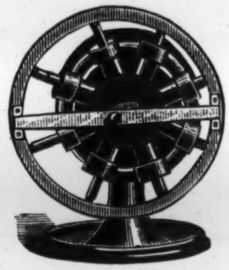
## POWER IN LABORATORIES.

MR. DAVID P. TODD, of Lawrence Observatory, Amherst, Mass., describes in *Nature* a novel and very effective form of water engine, with which he has been experimenting for several months. He says:—One of these motors is set up in the cellar of our science hall, where it is supplied with aqueduct-pressure of sixty pounds to the square inch, and the power is transmitted from it by means of rubber belting led over "idle pulleys" to the upper stories of the building, where a small engine-lathe and dynamo are driven. A word will suffice to explain the very simple construction of the motor—a system of radial cylinders, with their bases at the centre of the motor, through which runs the driving-shaft. The pistons in these cylinders are single-acting, and the water is admitted to them in succession by the rotary valve which forms part of the main shaft. The pistons, thus, in pressing outward, exert their force against a strong ring, to which is bolted a cross-bar which engages the crank of the main shaft. Thus the ring, in turning the shaft, has the vibratory motion of an eccentric, and returns the opposite pistons to the bases of the cylinders, at the same time exhausting the water through the interior of the rotary valve. Three pistons are thus constantly exerting a thrust upon the ring, whatever its position, and this thrust being always tangential to the arc of revolution of the crank, there is no "dead centre," and the uniform pressure at right angles to the crank at every part of its arc insures an even rotary motion and obviates the necessity of a balance-wheel. The ends of the piston-rods are slotted, and contain anti-friction rollers which bear against the ring, and this latter is grooved all round, so that, in addition to its simple and rapid motion as an eccentric, the ring is free to perform a slow motion of revolution independently of its work of driving the crank, and the wear of the interior face of the ring is thus equalised and becomes inappreciable.

The supply-pipe for this motor has a diameter of 1½ inches, and it gives an equivalent of nearly two horse-power. The flow of water is regulated by means of a balanced valve, under control from every point where the power is used. As the use of the power is, for the most part, discontinuous, like that in lathe-work, I find it better to start and stop the motor as often as desired than to use the ordinary device of shifting a belt off and on a loose pulley. All possible economy of water is assured, as none of it runs to waste without giving its equivalent of power at just the time when it is required. It will be seen that this form of motor is specially adapted to such uses, as there is no fly-wheel whose inertia has to be overcome; and as the motor has no "dead centre," it readily starts from any position, overcoming a maximum resistance.



SIDE VIEW.



FRONT VIEW.

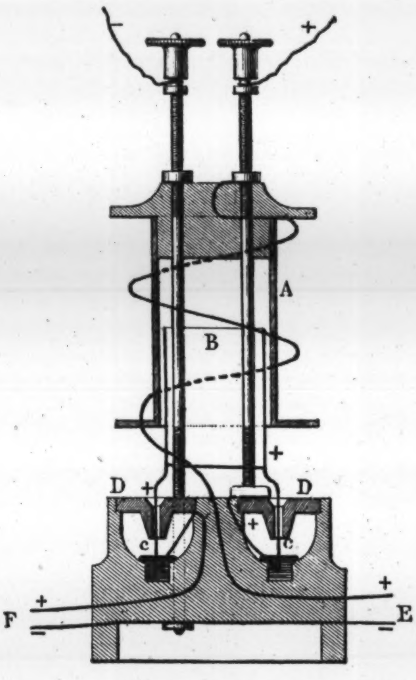
Where continuous running is required, at an invariable speed, a centrifugal governor is attached to the belt-wheel, and acts upon the amplitude of vibration of the ring, diminishing the stroke of the pistons when the resistance is removed. The governor thus gauges the water-supply exactly proportional to the resistance to be overcome, and makes the motor a very effective driving-power for dynamos and all sorts of machines and apparatus in which a uniform speed is necessary, while the resistance is variable.

The difficulties barring the economic use of water as a motive-power, owing to its weight and incompressibility, seem to have been successfully overcome in this form of motor, with which unexampled speeds have been attained, and more than 80 per cent. of the theoretical power of the water derived. The little cut annexed shows the smallest size of these motors—it stands about 10 inches high, and uses a ½-inch supply, consuming less than six quarts of water in 100 revolutions. I frequently run it at a speed of 1,000 revolutions to the minute, and at the manufactory I have seen the same motor attain double this velocity. The motor runs equally well with compressed air (or with steam, if the piston packings are changed), and with either of these media even higher speeds are attainable.

I find that the constant readiness of the motor for the immediate development of power, the little care it has required (only occasional oiling), and its economical consumption of water, are very great advantages in its favour; and, for all laboratories supplied with aqueduct-pressure, I venture to think that it affords the best solution of the problem of inexpensive, convenient, and effective power.

## AUTOMATIC SWITCH FOR GLOW LAMPS.

THE object of this invention, which is due to M. L. Clerc, of Paris, is at the very moment of the rupture of a glow lamp to automatically substitute another. The accompanying sketch shows the arrangement of this apparatus. An upright electro-magnet, A, is fixed in the circuit of the lamp in use. In the interior of this electro-magnet there plays freely a core of soft iron formed of a small ferrule, B, of thin sheet iron in which are cut two little strips, projecting at its lower extremity. These vertical rods can plunge into the two cups of mercury, D. As long as the lamp in use at E is burning, the current passing into the electro-magnet lifts the small iron cylinder and the circuit of the reserve lamp remains open. If an accidental extinction takes place the rods, *c*, plunge into the mercury and the circuit of the reserve lamp at F is closed. The light is not interrupted in an appreciable manner. At each normal extinction of the lamp the suppression of the current allows the ferrule of soft iron to fall. On closing to light the lamp the current passes for an instant both into the service lamp and the reserve lamp, but as the ferrule is immediately raised by the passage of the current into the bobbin the reserve lamp is at once thrown out of circuit. As may be seen in the sketch the small cups, D, are so arranged as to prevent the spilling of the mercury.



## THE NEW INVENTION OF C. A. BELL.

THE accompanying figures, for which we are indebted to the New York *Electrical Review*, illustrate some of the discoveries of Chichester A. Bell, cousin of Prof. A. G. Bell, the telephone inventor. Under the title of "Sympathetic Vibration of Jets," Mr. Bell, in a paper read before the Royal Society, states that his attention was directed to the subject by the accidental observation that a pulsating air jet directed against a flame caused the latter to emit a musical sound. The pitch of this sound depended solely on the rapidity of the jet pulsations, but its intensity was found to increase in a remarkable way with the distance of the flame from the orifice. In order to study the phenomenon, air was allowed to escape against the flame from a small orifice in the diaphragm of an ordinary telephone, the chamber behind the diaphragm being placed in communication with a reservoir of air under gentle pressure (fig. 1). Vibratory motions being then excited in the diaphragm, by means of a battery and a microphone or rheotome in a distant apartment, the discovery was made that speech as well as musical and other sounds could be quite loudly reproduced from the flame. Certain observations led the author to suspect that motion of the orifice, rather than compression of the air in the chamber, was the chief agent in the phenomenon; and, in fact, precisely similar results were obtained when a light glass jet tube was cemented to a soft iron armature, mounted on a spring in front of the telephone magnet (fig. 2).

Experiment also showed that an air jet at suitable pressure directed against a flame repeats all sounds or words uttered in the neighbourhood (fig. 3). Except, however, where the impressed vibrations do not differ widely in pitch from the normal vibrations of the jet (discovered by Sondhauss and Masson) these effects are likely to escape notice owing to the inability of the ear to distinguish between the disturbing sounds and their echo-like reproduction from the flame.

FIG.1.

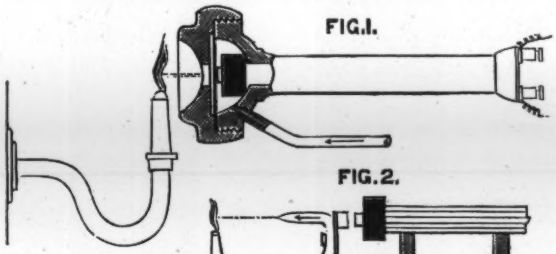
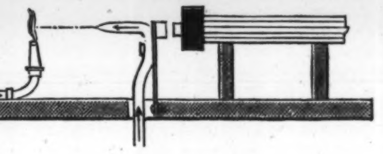


FIG.2.



In these experiments the primary action of the impressed vibrations was undoubtedly exerted on the air jet; but a singular and perplexing fact was that no sound, or at best very faint sounds, could be heard from the latter when the flame was removed, and the ear, or the end of a wide tube connected with the ear, was substituted for it. Suspecting, finally, that the changes in the jet, effective in producing sound from the flame, must be relative changes of different parts of it, the author was led to try a very small hearing orifice, about as large as the jet orifice (fig. 4). The results were most striking. By introducing this little hearing orifice into the path of a vibrating air jet, the vibrations can be heard over a very wide area. Close to the jet orifice they are so faint as to be scarcely audible; but they increase in intensity in a remarkable way as the hearing orifice is moved away along the axis of the jet, and reach their maximum at a certain distance. Experiments with smoked air showed that this point of maximum sound is that at which the jet loses its rod-like character, and expands rapidly; it has been named the "breaking point," because just beyond it the sounds heard from the jet acquire a broken or rattling character, and at a greater distance are completely lost. The distance of the breaking point from the orifice diminishes as the intensity of the disturbing vibrations is increased, and also depends to some extent

FIG.3.

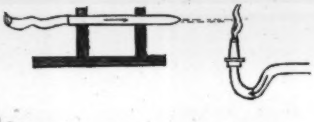
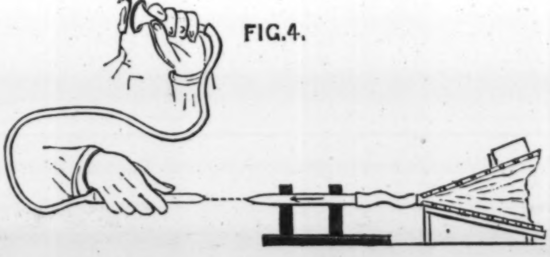


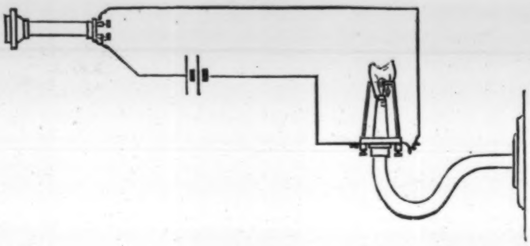
FIG.4.



on their pitch and on the velocity of the jet. With orifices of from 1 to 1·5 mm. in diameter, it usually varies from 1 to 6 cm. The vibrations of an air jet may also be heard at points not situated on the axis; but they are always most intense along the axis, and become rapidly fainter as the distance from it increases.

When a vibrating air jet plays against a small flame, the best sounds are heard when the stream strikes the flame just below the apex of the blue zone. At the flame of contact an intensely blue flame ring appears, and this ring vibrates visibly when the jet is disturbed. The production of sound from it doubtless depends on changes in the rate of the combustion of the gas. This may be proved by inserting into the ring a fine slip of platinum, connected in circuit with a battery and telephone shown in fig. 5.

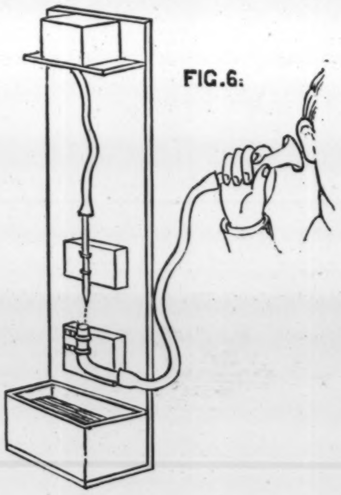
FIG. 5



When the jet is thrown into vibration the consequent variations in the temperature of the platinum affect its conductivity, and hence a feeble reproduction of the jet vibration may be heard in the telephone.

In order to assist the action of aerial sound waves on the fluid it is advisable to attach the jet tube rigidly to a pine sound-board about three-eighths of an inch thick. The surfaces of the board should be free, otherwise it may be supported in any way. The receiving membrane is formed by a piece of thin sheet rubber tied over the end of a brass tube about three-eighths of an inch in internal diameter. A wide flexible hearing tube, furnished with an ear-piece, is attached to the brass tube. The jet tube is connected with an elevated reservoir by an India rubber pipe, indicated in fig. 6; with an apparatus of this kind and a tolerably wide jet tube, having an orifice about 0·7 mm. in diameter, a pressure of about 15 decimeters of water is required to bring the jet into condition to respond to all the tones and overtones of the speaking voice (except hissing sounds) and those employed in music. At a somewhat higher pressure it will reproduce hissing sounds.

FIG. 6.



To get an accurate and faithful reproduction of the jet vibrations it is simply necessary to insert into the nappe two platinum electrodes in circuit with a telephone and a battery having an electromotive force of from 12 to 30 volts. Loud sounds can thus be obtained from a jet which is finer than the finest needle, and the arrangement constitutes a highly sensitive "transmitter," shown in figs. 7 and 8.

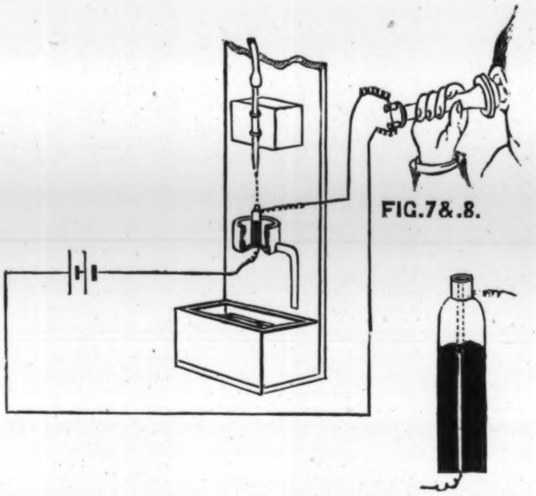


FIG. 7 & 8.

The foregoing are little more than the outlines of a new theory of jet vibrations. The author hopes to supply in the future further experimental evidence in support of it.

## INFLUENCE OF ALTERNATE HEAT AND COLD ON METALS.

It is a well-known fact that when wrought iron bars are subjected to a sudden chill they lose in length, or in other words are contracted, while in the case of cast iron and copper it is just the opposite. Herr Edward Wehrenfennig has lately made some experiments for ascertaining the differences which exist in that respect between various metals, and the results obtained by him were published in the *Organ furdie Fortschritte des Eisenbahnwesens*. Possibly the makers of dynamo machines will find these experiments interesting.

A.—*Experiments with Wrought Iron.*—These experiments were made with rods of from 60 mm. down to 1 millimetre in diameter, and then with flat iron and iron plate at various temperatures. It was found (1) that the highest temperatures produce more contraction than lower ones. Thus a bar of 26 millimetres square contracted ·023 per cent. when heated up to 572° F. and then chilled in water. A temperature of 752° F. produced a contraction of ·087 per cent. (2.) When iron is first subjected to a sudden chill and then to a sudden increase of temperature, it is liable to contraction. (3.) Protracted heating tends to promote contraction. (4.) The proportion in which the contraction takes place depends a good deal on the section of the metal, as appears from the following tabulated statement:

| | Diameter. | | Per cent. | |
|---|---|---|---|---|
| Round iron | 60 to 40 mm. | contracted | ·069 | Average of 30 experiments. |
| | 20 to 17 mm. | „ | ·065 | |
| | 8 to 5 mm. | „ | ·066 | |
| Wire of …… | 3 to 1·5 mm. | „ | ·025 | |

or, in other words, wire increased in length. A trial made with two flat pieces of iron of 13 and 15 millimetres in thickness showed that the length and breadth of the former were increased and its thickness reduced, while the latter expanded in every direction.

B.—*Experiments with Steel.*—Steel, when subjected to heat and cold, behaves, on the whole, like wrought iron; still, there are varieties of steel in which no change is perceptible in any direction. Subjoined are the results of an experiment made with an iron bar of 55 mm. and 30 mm. in section, and repeated three times. Contraction of the bar when first heated and then chilled;

| | Per cent. |
|---|---|
| First time in air ... ... ... ... ... ... | ·001 |
| Second time in water ... ... ... ... ... | ·125 |
| Third time in water ... ... ... ... ... | ·107 |
| Fourth time in water ... ... ... ... ... | ·096 |
| | ·329 |

C.—*Experiments with Copper.*—A copper bar 1·800 metre in length and 55 mm. in diameter was first brought up to a high temperature, and then chilled in water, together with an iron and a copper wire of 2·5 mm. thick. The result was that the bar increased 3·3 mm., the copper wire 7·5 mm., the iron wire 4 mm. in length.

D.—*Trial with Cast Iron in the Shape of Bars.*—When chilled in water or air, these bars underwent a contraction of ·05 per cent. in length.

## INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 576.)

*Thursday, May 13th,* 1886—(*continued*).

THE SOLICITOR-GENERAL: I now have to open this case on behalf of the defendants, but before doing so I may remark that your lordship knows that there are three patents which are sued upon, Edison's patent for the lamp; Swan's patent for what I will call "running the pumps," that is to say, clearing the occluded gases by the pump after the electricity has passed through the burner; and, thirdly, Gimingham's patent for the connection. I have first to submit to your lordship on Edison's patent—and that, of course, will put an end to the case if your lordship is of that opinion—that there is no evidence of infringement. I have not been able to be here the whole of the time during which this case has been before your lordship, but I have read the evidence which was given while I was not here, and I have read the evidence given while I have been here, and I think I am correct in saying that not one particle of evidence has been submitted to your lordship for the purpose of establishing any infringement of Edison's patent. That depends, of course, to a certain extent, upon the construction which has been placed upon Edison's patent. Now, let me take the claims in Edison's patent in order. The first claim which he makes to an invention is: "An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described and sealed to metallic wires." I will assume for the present purpose that the burners in the lamps, manufactured by Woodhouse and Rawson, are filaments. But your lordship observes that the claim is for a lamp giving light by incandescence, consisting of a filament of carbon of high resistance made as described. My learned friend, Mr. Charles, and myself, in the course of the cross-examination of the plaintiffs' witnesses, have been careful and scrupulous to try, as far as we could, to ascertain what, according to their view, was the description of the manufacture in Edison's patent. I will give the largest latitude that my learned friends can desire to Edison's patent for this purpose; I will say that it includes filaments made by carbonising a thread, that it includes filaments made by carbonising a fibrous vegetable substance, that it includes filaments made by carbonising cotton or thread, wooden splints, paper coiled in various ways, also lampblack, plumbago, and carbon in various forms mixed with tar. I will assume that any one of those forms of carbon filaments are within the description. Then, I say, there is not one particle of evidence before your lordship, and I say it without hesitation, and I will defy my learned friends to point it out, to show that the burners manufactured by Woodhouse and Rawson are made in any single one of those modes. I am not quite sure that I am strictly accurate in what I am about to say, but my learned friends will find the passage. I say that there is not one gentleman who has been called who says even that he believes it, and what is more remarkable the electrician of the company, Dr. Fleming, a person of great electrical knowledge, a person who has professionally studied these things, and who has told us that he is the electrical adviser of the company, was called, and he said that he had broken one of the lamps which purported to come from the defendants, and which I will assume did come from the defendants. Dr. Fleming was asked as to the infringement of Gimingham's, but not as to the infringement of Edison's patent. Not a single question was put to Dr. Fleming for the purpose of proving that these lamps were infringements of Edison's patent. He is the witness we should have expected to give evidence of some infringement. We should have expected him to say that our carbon filament was made as described by Edison. I need scarcely say that I should not take this point did I not know that it is a substantial point. It is not a mere defect of evidence. I am most anxious to shorten this case if I can, and I submit to your lordship that there is no evidence that our carbon filament was made in any one of the ways which Edison has described.

MR. ASTON: Page 26 of the notes, I think, you are looking for? Sir Richard Webster asked Sir Frederick Bramwell: "Do you believe that filament to have been formed as a filament before it was carbonised?—(A.) I think so. I know no process by which it could have been made out of an existing piece of carbon. (Q.) Assuming that you are right, you say that the combination there is the same combination as that of Mr. Edison?—(A.) Yes." And there was no cross-examination as to that.

The SOLICITOR-GENERAL: I beg Mr. Aston's pardon, but the very first question Mr. Charles asked Sir Frederick Bramwell on the cross-examination was this: "I wish to ask you about this lamp. Can you tell me whether it bears any trace of being made of a fibrous material?—(A.) You mean the filament? (Q.) Yes. —(A.) Not the metallic wires? (Q.) No; I mean the filament.—(A.) I cannot say that it is. But there is nothing to show me that it is not. In that case I hardly know how to answer your question. I can't say precisely whether it is or not." And that is the only evidence my learned friends can point to. Then another lamp was put before Sir Frederick Bramwell, but there is not one single sentence of evidence beyond that passage in Sir Frederick Bramwell's evidence, which is not evidence, because it is merely his belief, that this filament was made in any of the modes described by Edison. We know the modes described by Edison, and every one of them, giving my learned friends the benefit of the fullest interpretation of Edison's patent that they can desire, is either a fibrous material or a mixture of lampblack and tar. There is no other mode pointed out of making the filament. Edison says: "I have discovered that even a cotton thread, properly carbonised and placed in a sealed glass bulb, exhausted," and so on, "is absolutely stable at high temperatures; that if a thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber," and so on; and then there is a passage about the lampblack and tar, which I need not trouble myself about, because nobody says that the filaments are made of lampblack and tar. Then he speaks of cotton and linen thread, wooden splints, paper coiled in various ways; and all he says is that it appears to him that these things may be used. It is this evidence upon which persons are to be charged with a tort. Sir Frederick Bramwell's evidence in answer to the question: "Do you believe that filament to have been formed as a filament before it was carbonised?" was: "I think so." What has that to do with it? He does not tell you it has to be formed as a filament before it is carbonised. I asked Dr. Fleming to explain what he meant by "made as described by Edison," and what he told me, in effect, was that it was a carbonised thread of fibrous substance. Is that evidence upon which persons are to be charged with a tort and to be made liable for infringing a patent, and for damages? I submit it is not; and I must say that my learned friends, if they had had such evidence, would have produced it. But in point of fact they have not, and I deny that Sir Frederick Bramwell's belief is evidence. We want evidence of fact, not of belief. Therefore, I submit to your lordship that there is no evidence before you that the burner which is used in this lamp is described in Edison's patent. Now, let me take the next claim: "The combination of a carbon filament within a receiver made entirely of glass through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth." Do my learned friends, for they have never said, construe that as meaning a carbon filament of any kind or sort, or made in any way whatever, or do they say that it means a carbon filament made as described by Edison? Let them take their choice. I think I am right in saying they have not told the court how they construe it; and I must say it is a most extraordinary proceeding in this case, and not the only extraordinary proceeding, that the patentee, with the exception of Gimingham, of neither of these patents was called to explain the patent to your lordship or to explain what he had done. If it means a carbon filament—which I think Sir Richard Webster, in his opening, said was the meaning he sought to attach to it—as described by Edison, then I say again there is no evidence of the infringement. Of course, if it means a carbon filament made in any imaginable way in which a carbon filament which is a thread of carbon can be made, then other objections lie to the patent; and I scarcely think my learned friends would be so bold as to put that interpretation upon this claim. If they do, then other considerations will apply, because undoubtedly the lamps which are manufactured by Woodhouse and Rawson, and upon which they have acquired so large a reputation, are made with a burner which we have described as a carbon filament; but they are not made in the way described by Edison, or anything like it. My friends have no right to put upon me the proof of how my carbon filament is made. It is for the plaintiff, who comes forward and complains that his patent has been infringed, to make out the infringement, and to make it out by reasonably clear evidence, not by the belief of a gentleman who says he cannot say whether it is or not, because that is the effect of Sir Frederick Bramwell's evidence; but to make out by reasonably clear evidence which satisfies the court that, until it is answered, it is made as described in the patentee's invention. Of course, if my learned friends ask your lordship to construe, and if your lordship construes that second claim as meaning a carbon filament of any sort or kind, or made in any way whatever which may, in accordance with the English language, be described as a carbon filament, then of course entirely different considerations would arise, and if that be the construction of the second claim, if your lordship thinks I am not called upon to answer Edison's patent, my task will be an extremely easy one. Then, the third claim is a distinct claim for the spiral, and that is important because it shows that he regarded the spiral and the part of the letterpress which relates to the spiral, as a distinct head of invention, and as something entirely different from anything he was referring to in the first and second claims. It is not alleged that we infringe the third claim, and it could not be possibly alleged. The fourth claim is: "The method herein described of securing the platina contact wires to the carbon filament, and carbonising of the whole in a closed chamber substantially as set forth." It is for securing the platinum. There is not one shred of evidence that we do anything of the kind. The only evidence before your lordship as to the mode in which we make our joints is that given by Dr. Fleming, in which he stated that, in his opinion, it was similar to Gimingham's, but that we do it in the way pointed out by Edison, by using a cement for the purpose. That is on page 4. He refers to it in three passages, I think. At line 22 I find: "I have discovered that if platinum wires are used, and the plastic lampblack and tar material be moulded around it, in the act of carbonisation there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps, hence the light-giving body and platina wires are connected and ready to be placed in the vacuum bulb." There is not one shred, or tittle, or particle of evidence, not one witness even says he believes we do anything of that kind. The next passage is: "When fibrous material is used the plastic lampblack and tar is employed to secure it to the platina wires before carbonising." There is not one iota of evidence that we use plastic lampblack and tar for that purpose, and it would be impossible that anyone could say so. I am quite sure that if anyone could have said even that they believed it, they would have said so; but there is not one atom of evidence. The third passage, which I think is the only passage relating to the securing of the joints—if there is any other passage I am sure my learned friends will remind me of it—is at line 44 of the same page: "The ends of the carbon or filament are secured to the platina leading-wires by plastic carbonisable material, and the whole placed in the carbonising chamber." All I can say is, there is no evidence that we do that. The only evidence as to our mode of securing is with respect to Gimingham's, which, of course, is a separate thing. That has a material bearing also upon the first claim. Even if they could show any evidence that our filament of carbon was made as disclosed in Edison's patent, which they have not, the first claim is not for a carbon filament made as described, but for the combination of an electric lamp giving light by incandescence, consisting of a filament made as described and secured to metallic wires as set forth. I have already submitted to your lordship that there is no evidence that our filaments are made as described, but I am quite sure that my learned friends will not suggest that there is any shred of evidence that they are secured to metallic wires as set forth in Edison's patent; so that, even if I am wrong in saying that there is no evidence to go to a jury, or that your lordship can consider of its being made as described, at any rate there is no infringement of that first claim, because the first claim is for the combination of a filament of carbon made as described and secured, so that even if it were made as described but not secured to platinum wires, as set forth, it would not be infringement. I submit to your lordship that there is no evidence which your lordship can consider, or which I am bound to answer.

Mr. Justice Butt: If there is no such evidence as would be evidence sufficient for a jury I suppose I am bound to say so. Your difficulty seems to me to be with regard to the second claim.

The Solicitor-General: I am quite content if my learned friends say that that means a carbon filament made in any imaginable way.

Mr. Justice Butt: I must not without hearing them express an opinion that there is no difficulty with the others. But the point you have to deal with seems to me to be the second claim.

The Solicitor-General: I quite appreciate that your lordship is assisting me in directing my attention to the proper points, and not expressing any opinion. I quite agree, if I may so. I am expressing myself as an advocate, but I do not feel any difficulty on the other claims; but as to the second claim, it either means the combination of a carbon filament made in any way whatever, new or old, in which it is possible to make a carbon filament, that is to say in which a carbon filament can be made within a receiver made of glass, through which the leading wires pass, or it means the carbon filament described by Edison. I confess I think that is the meaning of it, and in that case my task will be very easy, because I cannot see that any human being can support this patent if that is the meaning of it. Or it may be that the meaning of it is, a carbon filament as described by Edison, and that, I gather from Sir Richard Webster's opening, is the meaning he desires to attach to it.

Sir Richard Webster: I never intended to say that.

The Solicitor-General: Do you say a carbon filament made in any other imaginable way?

Sir Richard Webster: I say a carbon filament made in a receiver of glass is an infringement of our patent.

The Solicitor-General: Whether made according to your patent, or not?

Sir Richard Webster: A carbon filament which has the characteristics of our carbon filament. There is no reason for the Solicitor-General to laugh at me. I am not putting anything which is not perfectly clear, as you will see if you have had time to read Dr. Hopkinson's evidence. It is a carbon filament of an exceedingly small cross-section, which has the characteristics of resistance and the other attributes described in the specification. I should not have interefered if the Solicitor-General had not appealed to me,

The Solicitor-General: I do not even now know what my learned friend means.

Mr. Justice Butt: My position is this: unless I am prepared to say now, and to hold that the words in the second claim, the combination of a carbon filament, necessarily mean a carbon filament made as described, I do not think it possible for me to say that there is no evidence.

The Solicitor-General: No, my lord. I agree in that.

Mr. Justice Butt: I am not prepared at all to say that I think that is meant, and that I ought so to interpret the words, the combination of a carbon filament as described in the specification.

The Solicitor-General: Then my learned friend must fall back on the more extended claim.

Mr. Justice Butt: That I have nothing to do with at present. If I am not prepared to say it means a carbon filament as described here, then there is evidence, and we must go into the case. You may get them into a dilemma, but that I have nothing to do with.

The Solicitor-General: I quite agree, my lord. If your lordship is of opinion, without expressing anything conclusive at the present moment, and if the argument is to proceed on the assumption that the true construction of the second claim is that it means a carbon filament of whatever kind, that is, whatever can be properly described as a carbon filament, then I agree that the burner which these gentlemen use, and in the manufacture of which they have had so much success, is a carbon filament. I quite agree with that; I do not shrink from that for a moment. But then my task in attacking the patent becomes, comparatively speaking, easy, because then we have the claim to a glass receiver.

Mr. Justice Butt: This would be on the other part of the case, would it not?

The Solicitor-General: Yes.

Mr. Justice Butt: Unless I hold, and I am really not prepared at the present moment so to hold, that with "the combination of a carbon filament" I must include "made as described," then there is evidence to go to the jury, as one would probably say elsewhere, and then I must hear the evidence. That may involve a difficulty to the other side. But so it is.

The Solicitor-General: If it is not confined to the carbon filament made as described in the patent, then I do not at all dissent from the view your lordship has expressed. Then your lordship would wish me to open the case?

Mr. Justice Butt: I think I had better hear what the other side has to say upon this point. You have at present submitted that neither under all or any one of these claims is there any evidence which could go to the jury in a court of common law; and if not, I am bound to stop the case here. On the other hand, if there is evidence I am bound to let it go on.

Mr. Aston: My lord, I have very little to say on this point. The second claim is, I submit to your lordship, a combination of *a* carbon filament, not *the* carbon filament, within a receiver made entirely of glass, through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth. Sir Richard Webster puts it very pointedly to Sir Frederick Bramwell: "Is that a carbon filament?"

Mr. Justice Butt: Of course, it is sufficent to satisfy me that under the second claim there is evidence. Therefore you do not propose to offer any observations on what would be said of claims one, three, and four?

Mr. Aston: Not on three and four, but on number one.

Mr. Justice Butt: You say there is evidence under claim number one?

Mr. Aston: I would rather deal with claim number two first if your lordship will allow me, and then we will deal with claim number one afterwards. Under claim number two, even after what the Solicitor-General has said, I say that the question as to the infringement is one which has already been answered, because the Solicitor-General says, very fairly, if it be a carbon filament made entirely of glass, through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth, if that applies to any filament which is of carbon, then, says the Solicitor-General, if I understand him rightly, I cannot dissent from the statement that Woodhouse and Rawson's is a carbon filament; and Sir Frederick Bramwell said the same. The question was put to Sir Frederick Bramwell: "Is that fibrous?" He said: "I cannot tell," and then afterwards in cross-examination the same question was repeated; but at the close of the examination of Sir Frederick Bramwell on the second day, it was put to him: "Whether it be fibrous or non-fibrous, is that an Edison filament?" and he said "Yes."

The Solicitor-General: That is for the court.

Mr. Aston: I quite admit that the Solicitor-General is perfectly justified in the statement that it is for the court, whether it is an Edison filament or not, but with regard to the question of infringement the evidence is there given, because Sir Frederick Bramwell says that the filament which is in the defendants' lamp, whether fibrous or non-fibrous, is an Edison filament. Now, let me go back to the second claiming clause. The second claiming clause is a combination claim, as we all know, and a combination claim in which many of the parts may be old, and not a bit the worse a claim for that. What is the claim? "The combination of a carbon filament within a receiver made entirely of glass, through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth." It is not denied that it is an exhausted receiver. What have we here? We have that which the Solicitor-General says is a carbon filament. And then he goes on to another part of the case, and says: "Do you mean to say that carbon filaments are within Edison's claim?"

I say carbon filaments, such as the carbon filaments referred to by him. However made? Yes, certainly, however made. To that I give a most decided answer. Not the less would it be a carbon filament if a man were to-morrow to discover, as I daresay the defendants have discovered, that they may make, in a particular way, a particular filament. They may improve upon the manufacture of the filament, but the question is, have they the characteristics of flexibility, resiliency, or elasticity, and the capability of high resistance, which Edison has described in the body of the specification? Our witnesses have said: Certainly, otherwise it would not be a good lamp; and that is the way we have put it. The infringement of the second claim has been put beyond question, or at all events, it has been put to such an extent as to shift the onus upon the defendants of proving that it is not so. As we know, there have been many cases where it has been impossible to ascertain what it is the defendant has done, and the course which has been taken in many of these cases has been for the plaintiff to make a *prima facie* case, and the courts have then held that if the plaintiff makes a *prima facie* case and the defendant does not venture to answer it, then we should of course say that that which the plaintiff believes, or that which the plaintiff's witnesses believe to be the way in which the infringing article is constructed, is the way in which it is constructed. I say that, as regards the second claim, there is direct evidence that there is a filament, such as is described by Edison, used in the way Edison describes for the purposes Edison set forth, namely, for the purpose of being used as an incandescent lamp, and therefore there is abundant evidence of infringement. In fact, at all events, a *prima facie* case so strongly put that the onus will light on my learned friends to answer it. Now, with regard to the first claim; it is "an electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance." Is not that a carbon of high resistance? Nobody has denied it.

Mr. Justice Butt: Made as described.

Mr. Aston: I will come to that in a moment. It is a filament of high resistance. Now, "made as described." Of course, nobody can tell whether that has been made as described, in the sense of being made according to the particular details; but it is made as described in this sense, that it is not cut out of a block of carbon. Every one of the witnesses for the plaintiff said it would have been impossible for that to have been cut out of a block of carbon. It must have been made. Then how, if it was not cut out of a block of carbon?

The Solicitor-General: Nobody has said so.

Sir Richard Webster: My recollection is distinct that it has been said.

Mr. Justice Butt: My recollection is that, I do not say all, but some of the witnesses have said that it could not have been cut out of a block of carbon?

The Solicitor-General: I did not understand what my learned friends meant; if that is what they meant, I do not know that it is relevant.

Mr. Aston: Yes it is, for it could not have been made by taking a block of carbon and cutting it out of that block of material in such a way that it should have flexibility and that it should have elasticity. How must it have been done, then? It must have been done by first finding the thing in the shape it is to take eventually and carbonising it afterwards.

Mr. Justice Butt: If the words made as described would be satisfied by a description of the thing carbonised after the shape had been given to it, that would be so. But I suppose the other side would say that it may be made not only in the way described in the sense of being carbonised after making or part-making.

Mr. Aston: But in one of the modes.

Mr. Justice Butt: But in one of the modes suggested. That is what they contend.

Mr. Aston: I know, my lord; but upon that I should invite your lordship's serious attention to this: Suppose a man says, I want to have a carbon filament, and I tell him the best way I know of making it. I tell him that when it is made in my way and when it is joined in my way, and when it is put in a receiver in my way, that is the thing I claim, would there not be an infringement of that, if he were to depart from the details of the *modus operandi?* That would be a question for your lordship as to how far he had gone from it. Suppose it were to turn out that my friends insisted on having this, the exact mode of making it. Let me put an extreme case. We have spoken of having lampblack and tar. Suppose, instead of having lampblack and tar, they had powdered plumbago and oil, then I should ask your lordship to say that the thing the defendant had done was a manifest equivalent.

Mr. Justice Butt: That it was made as described, although not made of lampblack and tar?

Mr. Aston: Certainly.

Mr. Justice Butt: That is to say, made for something which was carbonised after making.

Mr. Aston: Certainly. And the question for your lordship, whether it is or is not an infringement, would be answered when your lordship had to consider how near they had come to, or how far they had gone from the *modus operandi*, if the *modus operandi* be part of that claim. First of all, we submit the *modus operandi* is not part of the claim. It will be made as described if you shape it before you carbonise it and give to an already prepared something a carbonisation which converts it into a carbonised filament in the sense of Edison's specification. That would be in accordance, I say, with the first claiming clause. Then if, in addition, the terminals are secured to wires in the way shown by the specification, that would be infringement. It is said they are Gimingham terminals. Is not that a way of connecting the end of the carbon filament to the platinum wires, which is substantially like the Edison way? We submit that it is. There is a difference of detail. The Gimingham arrangement is a very ingenious one; but it is also a very useful one, although it may be a departure from Edison's system of using plastic material for the purpose of giving a thick joint. What does it matter? Is there not a thickened joint in the defendants' lamp? Your lordship will remember that the witness said "Yes," and the question was whether that was a thickened joint which made it seem like Edison proposed that his filament should be secured.

The Solicitor-General: My learned friend says so, and I am sure he would not say anything unless he believed it; but my learned friends Mr. Charles and Mr. Macrory, who know much more than I do, say that no such question was put.

Sir Richard Webster: I don't think we did ask that question.

Mr. Aston: Sir Richard Webster says he does not recollect it, and, subject to reference to the notes, I give it up. If your lordship were to hold there that the first claiming clause required that the filament should not only be a carbon filament of high resistance like Edison's, but also be secured like Edison describes, your lordship will probably say on the first claim that there is no infringement. But that is of no importance so long as there is an infringement of any claim. I say that on any reasonable construction of the second claim, an infringement has been proved.

Sir Richard Webster: I will ask a few questions as to what Mr. Aston has said upon this point. I think a little mistake has arisen from my having carelessly used an expression which, I gather from the Solicitor-General's observations, he has a little misunderstood. I think if he had been here and heard what I said to Mr. Charles on the second day, when I pointedly drew his attention to this, he could not have raised this point. The Solicitor-General evidently thinks that when I said the filament had been shaped I meant that it had been shaped into the horseshoe shape in the burner. I did not mean that. I called attention to the third claim, in which there is a claim to the winding and a claim in which the carbon filament is spoken of without any mode of winding. When I spoke of shaping I meant shaping into a filament. I said to Sir Frederick Bramwell: "Has that been carbonised after it has been shaped into a filament?" not after it had been shaped into the horse-shoe shape.

The Solicitor General: I certainly did misunderstand my friend, and so did Mr. Charles.

Sir Richard Webster: I am sure Mr. Charles did not, and I will tell you why. I am sure nobody ever thought so before, but it has been my carelessness if I have misled the Solicitor-General. I have never used the word shape to mean shape in the form of the burner. I meant to point out that the science of making it as described is not the shape it takes in the burner, but the form in which it is made before it is carbonised.

Mr. Justice Butt: I recollect, in reference to what you say, a good deal of the evidence going to this, that a desideratum was to get a carbon filament which would be susceptible of being bent into the shape required for use. And that assumes that the thing was shaped into a filament and carbonised before it was bent.

Sir Richard Webster: Yes, my lord. This is a case in which *res ipsa loquitur* is quite enough for infringement. Edison points out that carbon rods of low resistance have been used; they have failed. Large terminals and large platinum leads have been used; they have failed. He says, I have reversed this practice; I have discovered that a cotton thread, properly carbonised, placed in a glass bulb, and so on, will do. He says, I have tried paper and wood, and lampblack and tar, I have tried wood splints, cotton and linen threads, but it is not the particular material. It is not the particular carbon which he is getting. The carbons vary. It is a carbon filament made as described in the sense of being, as Dr. Hopkinson put it, of very small sectional area, and therefore of higher resistance and allowing you to have very small platinum wires so that the glass does not break. I am glad that Mr. Charles is here. Thinking that he might have misunderstood the point, when re-examining Sir Frederick Bramwell, I think before I called Dr. Hopkinson, on the second day, I put this to my learned friend: "Assuming our patent to have this construction, you dispute infringement?" He then said: "I have cross-examined as to infringement, because I cross-examined Sir Frederick Bramwell as to whether it was fibrous." Then I ventured to point out that in our specification fibrous and non-fibrous constituents are mentioned, and that then that would not avail them. And then Mr. Charles asked to be allowed to cross-examine again, and that was the point, whether the carbon was inserted in the platinum in the way specified by Gimingham. There has not been a word of cross-examination from beginning to end on infringement, although I challenged my learned friend, Mr. Charles, and he has not suggested any way in which the lamp is not an infringment other than that it was not fibrous. I say any small carbon filament. I believe it would be correct to say, although I do not limit the patent in that sense, that they are all made into filaments or threads before they are carbonised; but I say any carbon filament of that description which gets rid of the defects Edison pointed out when heated in a glass bulb is an infringement. With regard to the first claim and with regard to what Mr. Aston has said, I pointed out to your lordship when opening the case that "secured to metallic wires" meant the case of securing to platinum wires as distinguished from the mode of securing, because if your lordship will look at the fourth claim, the mode of securing is generally claimed as distinguished from the combination. I submit, my lord, that there is abundant evidence for the defendants to answer.

Mr. Justice Butt: Do you want to say anything more, Mr. Solicitor-General, on this head? I do not know whether you have a right to do so on this question of no evidence.

The Solicitor-General: I think not, my lord. I should only like to say this, that my learned friends did not suggest that any evidence was given as to the particular mode of securing, and that that is an essential part of the first claim.

Mr. Justice Butt: As I read and interpret the second claim, I think it is clear that there is evidence for the court in respect of the case of infringement, and I am disposed to think also that there is evidence under the first claim, but I am not so clear upon that. That is the view I take of the second head of claim, and of course I must hear you.

The Solicitor-General: That is comparatively unimportant. It would not matter upon which point the patent was infringed, if there was infringement. I am not sorry to have had this discussion, because it has cleared the ground a good bit as to the interpretation we are to put upon the claiming clauses. I shall henceforth, in the observations I propose to address to your lordship, assume that what Edison intended to claim, and what he did claim, was the device of a carbon filament, that is to say, a carbon burner which could be described as a filament, in a closed glass chamber, with platinum wires sealed into it. I will trouble your lordship with a few observations as to the previous history of this lamp, because I do not altogether take the same view which my learned friends do as to what was known before Edison's time, and what it was lawful for people to do before Edison's time. There was a patent obtained by a gentleman named De Moleynes, which I will not trouble your lordship with. Why I refer to this is for the purpose of showing exactly what was the state of knowledge, and what was done at the time when Mr. Edison took out his rather vague and, according to the interpretation we are now told to put upon it, extremely large and sweeping patent, because I believe, if Mr. Edison is right in his interpretation, that there is not a single incandescent lamp now in use which will not be swept into the ambit of it. Your lordship's attention has been called to King's patent, taken out in the year 1845 and numbered 10,919. The important part of this specification is on page 2, line 5: "The nature of the invention consists in the application of continuous metallic and carbon conductors intensely heated by the passage of the current of electricity for the purposes of illumination." Pausing there for a moment, you will observe that what this inventor described, and what he says his invention consisted in, was the invention of continuous metallic and carbon conductors, the carbon conductors generally, as well as the metallic conductors, and he is also perfectly well aware, as he shows in line 10, of the necessity of having a conductor which will offer great resistance to the passage of an electric current. Then he describes a mode in which he proposes to make the metallic conductors, and at line 21 he says: "A strip is to be cut from one of these sheets of a width proportionate to the quantity of the current, which, in a Grove's cell having the platinum plates 3 inches long and 2 inches wide, is about a quarter of an inch, and of a length proportionate to the intensity, which of course varies with the number of cells, showing there that he was perfectly well aware that the resistance of the strip, as he calls it, in the place of the platinum conductors, would depend upon the amount of the electromotive force. The two factors to procure resistance—I do not pretend to use perfectly accurate language, but I think it will be intelligible—were the electromotive force compared with the size of the burner which is to be used. I will not trouble your lordship by reading all that he says about the metal conductor, and I will pass on to line 16 of page 3, where he describes the carbon conductor: "When carbon is used it becomes necessary, on account of the affinity this subject has for oxygen at high temperature, to exclude it from air and moisture. To accomplish this in the most perfect manner it should be enclosed in a Torricellian vacuum." Then he shows one form of the mode in which that may be done, and then (passing down to the bottom of that page) he says: "The circuit is thus completed by the column of mercury, and when it is depressed in the tube by the formation of vapour of mercury the connection is preserved by the copper wire, *n*. That form of carbon found on the interior of coal gas retorts which have long been used is well suited for this purpose." He does not confine himself to any particular mode of manufacturing his carbon conductor, but he points out that in his opinion, and according to his experience, the carbon which is found in gas retorts is well suited for the purpose—"and it may be"—my learned friends desire to read this as if it said "it shall be," but it is, "it may be worked into the form of either small pencils or thin plates by the aid of the saw and file." The patentee then gives the public the description of a way in which he considers the carbon conductors may be made. His patent is, whatever the value of the patent, for carbon conductors generally, and not for carbon conductors made by cutting the carbon either from the block of carbon found in the gas retort into thin pencils or plates, or in any other mode, although he suggests that as a mode in which he thinks it can be done. His patent is, and what he tells the world is, and what he claims the monopoly of is, "the application of continuous metallic and carbon conductors intensely heated by the passage of a suitably regulated current of electricity to the purposes of illumination as hereinbefore mentioned." The importance of that patent is this, that King's lamp, I believe, was made and successfully used for some time, although, for the reason I am going to mention, it was by no means a perfect lamp.

Mr. Justice Butt: That was an arc lamp?

The Solicitor-General: No, my lord, an incandescent lamp. It was the application of a continuous carbon conductor. De Moleynes had suggested something of the kind, but I believe this to be the first description of an incandescent lamp. This is the first real description of an incandescent lamp, and your lordship will observe what it was. His idea was to pass a current of electricity through what he describes as a carbon conductor. He does not confine himself to any shape or size of that conductor. Every shape and every size would be within his patent. But he gives, as patentees frequently do, a way in which, in his opinion and according to his experience, a carbon conductor may be made, and in giving that he describes that conductor as a small pencil, and it is to be in a vacuum. At that time the most perfect vacuum was the Torricellian, and that is what he gives us, although it is not an absolutely perfect vacuum. That was the best known incandescent lamp at that time. There were defects in the lamp, and the most serious of them was that you could not get a perfect vacuum. When I speak of a perfect vacuum, I mean a practically perfect vacuum. A vacuum as nearly perfect as possible is essential to the success of an incandescent lamp. In the next place, the theory of getting what this patentee sought, high resistance, was not so well-known by scientific men as it was subsequently. The laws by which you can get high resistance in a carbon conductor were not formulated with the same accuracy as they were at a subsequent date by Prof. Tyndall and others. And, moreover, although King did not know it, there were the occluded gases in the carbon even after you got the most perfect vacuum and enclosed your carbon conductor in it. Nevertheless, experiment has shown that when you pass a current of electricity through your carbon conductor and make it incandescent there is a deposit of soot—I believe I am right in calling it soot—or something in the nature of soot; and that is found to arise from what is called the occluded gases in the carbon which are released by the heat and impair the perfection of the vacuum. Another patent was taken out for an incandescent lamp, and that is the patent of Roberts, which is a patent of great importance. Roberts described a great many things which I need not trouble your lordship with. It is a patent for an incandescent lamp with a vacuum—and in fact for a carbon incandescent lamp the vacuum is necessary. On page 11 of the specification, line 20, Roberts says this: "Another part of my invention consists of a mode of obtaining electric light by passing a current of electricity through a thin piece of graphite, coke, or charcoal, or other infusible body being a conductor of electricity, while it is enclosed in a vacuum or space not containing any oxygen or other matter which can cause the combustion or destruction of it when brought into an incandescent state by the action of the current of electricity." That is what the inventor was aiming at. He obtained a light by passing a current of electricity through a burner in a vacuum, and your lordship knows that graphite is crystallised carbon. It is, I believe, the same substance as hard black lead pencils. The current of electricity is passed through a thin piece of graphite, coke, or charcoal, or other infusible body being a current of electricity. He describes a mode of doing that, and then on page 12, at line 4, he says: "Now the mode of operation with this apparatus is as follows: a piece of very thin graphite about half an inch long and half an inch wide, and as thin as conveniently can be made is fastened at each end into the clips, *h* and $h_1$, and firmly secured; the globe, *g*, is screwed air-tight upon the pillar, *b*, the stop-cock, *s*, is bent round the whole apparatus by a screw at the bottom of *b*, screwed down upon an air-pump or exhausting syringe; by this the air is drawn out of *g*, and as perfect a vacuum as can conveniently be made obtained." He saw the necessity for as perfect a vacuum as conveniently could be made. "When this is done the stop-cock is shut, and the apparatus is then removed from the pump to its stand, *a*, and a galvanic battery is put into connection with it by the binding screws, *f*, *f*, *x*. The electricity passes through the rods and thin piece of graphite, *j*, which becomes white hot from the passage of the electric current, and no combustion would ensue. If the vacuum be perfect, and no matter within the globe to cause combustion of the graphite, or if the graphite be not otherwise destroyed the light continues as long as electricity flows through the graphite in sufficient strength." We there have a description of another form of incandescent lamp, also imperfect, because the knowledge of that time of day did not enable the inventor or maker of this lamp to construct a sufficiently perfect vacuum. But it may be worth while for your lordship to turn to his figure on the first page, fig. 5, from which your lordship will see at a glance better than from the description what his idea was. The Sprengel pump was not invented then. In principle the lamp is precisely the same as the lamp we have been looking at. There are two wires connected with a battery below. They pass through what he describes as a block of glass, and then they are connected with a piece of graphite, *j*, at the bottom, and that is the burner. It is quite true that he proposes to use a pencil of natural carbon, but I do not know why he should not have got a pencil by artificial means as well as by natural means. I see nothing in his description which would bar him from using a piece of artificial carbon, if I may use that expression, that is to say, a substance not made by heating the carbon, as well as a piece of carbon like graphite. There cannot be any invention in that, and nobody who has given evidence before your lordship now pretends that the mode of making a carbon out of a thread or anything else is not—as old as the world, I was going to say.

Mr. Justice Butt: Old enough for you, at all events.

The Solicitor-General: Yes, my lord, old enough for me. Nobody has said that he could not have availed himself of the use of an artificial carbon as well as of a natural carbon like that. It is not unimportant to point out that what he claimed, according to line 20 on page 12, was this: "And with respect to this part of my invention, I claim the production of light by passing electricity through a thin infusible body being a conductor of electricity in manner hereinbefore described." He says, through a thin infusible body; he does not confine himself to a pencil of graphite, he does not confine himself to any size of conductor, he does not confine himself to any shape of conductor, but he gives as an illustration a piece of graphite half an inch long and half an inch wide and very thin. He gives that as an illustration, but he does not confine himself, and there is nothing whatever in his description which would confine him to any particular size or shape of carbon conductor or to any particular kind of material for making it. Those lamps, I freely admit, some witnesses will tell you were not a success, and they were not a success for the reasons I have mentioned, namely, that you could not get a perfect vacuum, and it was not until the invention of that very beautiful machine known as Sprengel's pump in or about the year 1873 (at any rate it was further brought into notice, according to my instructions, about that time), that you could obtain a sufficiently perfect vacuum to make an incandescent lamp. I believe Sprengel's pump has been improved upon, and that there may be mercury pumps which are superior to Sprengel's pump. At any rate, Sprengel's pump was introduced, and for the first time enabled you to get a sufficiently perfect vacuum. Thereupon people turned their attention again to the incandescent lamp. I am not going to take your lordship through all the anticipations; it will be sufficient for my purpose to say that Mr. Lane-Fox amongst others applied his attention to incandescent lamps. Mr. Lane-Fox's first patent to which I shall call your lordship's attention was a patent of 1878, No. 3,988. This patent is of importance. He does not describe a carbon conductor in terms, but he describes it as any suitable material. He says: "In order to produce a light I pass the electric current through a thin strip or wire of some suitable material, for which purpose I prefer to use an alloy of platinum and iridium." If it be necessary to construe Lane-Fox's patent I should without hesitation submit that "a thin strip or wire of some suitable material" would include carbon, although the patentee preferred and declared his preference for an alloy of platinum and iridium. "The electric lamp in which the light is produced therefore consists of two conductors insulated from one another, having this strip or wire between them and in contact with each." Your lordship observes that he calls his burner a strip or wire. Oddly enough (I do not want to make too much of the coincidence) wire is one of the terms used by Edison in his specification, for, describing the burner, he calls it in one place a carbon wire and in another place a strip, and he calls it thin wire. "The material or alloy employed should be capable of standing as high a degree of temperature as possible without fusing, volatilising or falling to pieces; it should also have a high specific resistance. The higher the temperature to which the material can be raised the more economical will be the light produced; that is, the light will be greater in proportion to the force or energy expended, inasmuch as the radiant energy proceeding from the surface of the material will be more and more luminous as the temperature increases. In order to prevent the deterioration of the material when incandescent, I sometimes surround it with an atmosphere of nitrogen gas." He did not use a vacuum; he sometimes surrounds the conductor with a nitrogen gas, which, although not so good as a perfect vacuum, has the same effect of preventing the oxygen of the air from destroying the substance. "The quantity of light will be proportional to the extent of the luminous surface. The resistance of the luminous material and its extent of surface should therefore depend on the amount of light it is required to give and the electromotive force used." My scientific witnesses will tell you, I believe (if they will forgive my unscientific language), that there you have expressed in a few words the whole theory of high resistance. You could not express it in a simpler or more concise form. You have the whole theory given you of what my learned friends and Mr. Edison apparently attach so much importance to, the theory of high resistance; and the statement is that the amount of light will depend upon the ratio which the electromotive force bears to the extent of the surface. "Speaking broadly, it may be said that the resistance of the luminous conductor should be so adjusted or fixed that the electromotive force of the mains to which it is attached is just sufficient to develop within it the strength of current necessary to raise it to the right degree of incandescence." You can regulate the degree of incandescence. "In order that the electric force may be conveyed at a high tension, that is, having high electromotive force, so that there may not be very great loss from the resistance of the conducting mains or conductors, I make the lamps, when I use an alloy of platinum and iridium, of lengths of fine wires, so that I may get a high resistance without having a large extent of luminous surface." We are told that one of the extraordinary merits of Mr. Edison's discovery and invention is this, that if you make your wire or burner as small as possible you get a high resistance, and you have all the conditions of a high resistance. Here you will find, so far as the principle is concerned—not the application of it—Mr. Lane-Fox, in the year 1878, describing in terms that very thing. He used lengths of fine wire for the very purpose of getting a high resistance without a very large extent of luminous surface. Then he gives you the detailed description, which I will not trouble your lordship with. Do not let my learned friends misunderstand me. I do not say that he described a carbon lamp, I do not say that he described a carbon conductor in vacuum; but I do say this, in giving your lordship the history of the way in which the present lamp, which, according to my contention, it is open to all the world to make and use, was built up. This patent of Lane-Fox's appears to those who instruct me to be of supreme importance as showing the recognition of the principle of using a fine conductor in order to make the resistance as high as possible. I have already pointed out to your lordship that, although what he described is a metal incandescent conductor, he does not confine himself to that, but treats it as applicable to a conductor of any suitable material, intending, no doubt, where he uses carbon or a conductor of carbonised material, to use nitrogen gas. If your lordship will look at figures 1 and 2 of Mr. Lane-Fox's patent, you will see the most striking resemblance to the lamps with which we are concerned. There you have the two wires coming in at one end, the two wires being *b*, *b*, connected with the burner, *a*, *a*, and the whole thing enclosed in a closed chamber.

Sir **RICHARD WEBSTER**: It has a metal bottom.

The **SOLICITOR-GENERAL**: It has a metal bottom; but the metal bottom was to be hermetically sealed, I think I am right in saying. Prof. Frankland tells me it was a glass bottom.

Sir **RICHARD WEBSTER**: I do not think so. I think Prof. Frankland is wrong. However, we will see. I will withdraw it if I am wrong.

Mr. **CHARLES**: I drew the attention of Sir Frederick Bramwell to this very figure.

Mr. **JUSTICE BUTT**: I think Sir Frederick Bramwell spoke of fig. 1 as a glass bottom.

Mr. **CHARLES**: Yes; he said those little things at the corner showed that.

Mr. **ASTON**: That is so.

The **SOLICITOR-GENERAL**: And the wires were fused into the end.

Mr. **JUSTICE BUTT**: He said at first he did not think it was fused, and then he looked at the two shoulders and said he thought it was.

Sir **RICHARD WEBSTER**: Sealed in glass, but I do not think he said the bottom was glass.

The **SOLICITOR-GENERAL**: Mr. Charles's recollection of Sir Frederick Bramwell's evidence, which agrees with mine, is that Sir Frederick Bramwell said he thought it was glass. Mr. Aston is under the same impression. I do not desire to bind anybody by admissions; but it does not matter very much whether it was glass or not. The importance of it is that it was a glass chamber hermetically sealed. It is not as if it was pretended that Edison's vacuum was a novelty. Nobody pretends that; but the importance of it is that it is a hermetically closed chamber with two leading wires fused into the top. Whether it was made in one piece or more pieces does not matter for the purpose for which I am using it. I only wanted to show your lordship the progress of discovery, and to show your lordship that at the date Lane-Fox took out his patent he was perfectly aware of the necessity of making his conductors, of whatever they were made, as small as possible. He calls them thin wires. I do not know whether your lordship will be able to distinguish between a thin wire and a filament. I cannot. But he calls them thin wires, and he uses them in a hermetically closed chamber from which the air is excluded. I quite agree that he does not propose to use a vacuum: but he proposes to use the equivalent of a vacuum, although something not so good, I believe, namely, an atmosphere of nitrogen. I do not want to overstate it in one particular.

Mr. **JUSTICE BUTT**: But it is simply another means of preventing combustion?

The **SOLICITOR-GENERAL**: Yes. Mr. Lane-Fox took out a provisional specification. There is no disclaimer to that.

Sir **RICHARD WEBSTER**: May I just mention that it is not combustion in an atmosphere of nitrogen as far as carbon is concerned. The carbon filament will not do in that case.

The **SOLICITOR-GENERAL**: He thought it would.

Sir **RICHARD WEBSTER**: I know he did. I quite agree.

The **SOLICITOR-GENERAL**: I am not putting this forward as an anticipation of my friend's patent, but to show how the lamp in its present perfect form has been built up. I think I said that nitrogen has been practically found not to be a success. I have not the scientific knowledge that my friend has, but I put it in this way without going into the reasons. There are two disclaimers, but I do not think anything turns on the disclaimers.

Sir **RICHARD WEBSTER**: As a matter of publication it would not matter whether it was disclaimed or not.

The **SOLICITOR-GENERAL**: No; so I do not propose to trouble your lordship by calling attention to that. Mr. Lane-Fox took out another patent in 1878 which is numbered 4,043. The patentee proposes in that patent to employ as his conductor in an incandescent lamp a thread of asbestos coated with carbon in some form. I do not think it is important, but he says at line 21 of page 3: "I sometimes employ asbestos or other suitable non-conducting refractory material, saturated or impregnated with some conducting, refractory material, such, for example, as carbon or iridium. The asbestos may be woven or made up in the form of paper." In the specification of his former patent he says: "In order to produce a light I pass the electric current through a thin strip or wire of some suitable material, for which purpose I prefer to use an alloy of platinum and iridium. The electric lamp in which the light is produced therefore consists of two conductors insulated from one another, having this strip or wire between them and in contact with each." Then in the specification to which I am now referring he goes on: "Figs. 1 and 2 represent an electric lamp in which the luminous surface, which I will term the bridge, is made of asbestos, or similar non-conducting material, saturated or impregnated with some refractory, conducting material, such as carbon or iridium. *a* is the bridge held by metallic clips, *b*, *b*, which are attached to the conductors, *c*, *c*; these conductors pass through the top, *d*, of the flask, *e*, which is hermetically sealed, and which is filled with nitrogen gas. The luminous portion, *a* to $a_1$ of the bridge, is of higher resistance than the rest." His object was to give some consistency. He recognised the necessity of having the conductors as thin as possible, and in order to give them consistency he proposes to unite them with some non-conducting, refractory material, such as asbestos, which would not be useful as a conductor, but which would, to use popular language, hold the conductor. But he still recognises the necessity of having them as fine as possible, and it is in order to get them so that he proposes to use this non-conducting, refractory material with it. Then there was a provisional specification of Lane-Fox's, No. 4,626, of 1878. In this we have a vacuum. "In order to obtain light from an electric current I make use of a sheet of platinised, or iridised, or carbonised asbestos, or other suitable material, supported between two conducting terminals of platinum or other suitable material, and in order to preserve the incandescent substance in a good condition and prevent its deterioration, I enclose the whole in a glass or other suitable transparent vessel or cover, through which the platinum supports are fused." There we have a vacuum. Of course Mr. Fox knew of the invention of Sprengel's pump. We have the glass vacuum with the platinum wires fused into it. "This vessel or cover is then exhausted of air by means of a small tube leading from it, and it may then, if thought desirable, be filled with some gas or vapour." But that is only an alternative which he proposes, and not part of his invention. "When platinum, iridium, or other metal is used, either pure or alloyed with some other material or materials and either plain or covered with some suitable material such as powdered asbestos, magnesia, or a vitreous substance, I prefer to coil a long strip or wire into the form of a spiral." Here we have Edison's spiral. "And to attach the two ends to platinum wires fixed side by side by fusing into it a piece of glass or otherwise so that they run parallel to one another, one wire carrying the top of the spiral and the other the lower end. The ends of the spiral should be united to those wires with some hard solder. The spiral is then enclosed in a globular or flask-shaped glass vessel whose neck is sufficiently large to admit it, and the neck should then be closed up around the two supporting wires so as to seal them in and make the whole vessel air tight. A small tube projecting from some part of the neck is then connected with a Sprengel air pump, or other exhausting apparatus, and the air is then removed as completely as possible and the tube sealed up, some gas being previously admitted, if desired, into the vessel as before described." There he describes the incandescent lamp precisely the same as that which is now in use, with this exception, that the conductor was not of carbon. One question which will be submitted to your lordship, it being known that carbon is useful for the purpose and had been described for the purpose of making a burner for an incandescent lamp, is whether there is any invention in substituting carbon wire for a platinum wire, or a metal wire such as Mr. Lane-Fox describes. We shall submit to your lordship, although that is perhaps a bye point, that there is not, and that there could not be any invention. Mr. Lane-Fox recognised that it must be fine. He described it and told the world.

Mr. JUSTICE BUTT: Distinctly.

The SOLICITOR-GENERAL: And all the world knew that the fineness of the conductor was the object. It may be that the world had not then used a fine carbon conductor, but all the world knew what Prof. Tyndall had told them as applicable to wire. I am afraid to quote from a scientific man without having the words before me, but Prof. Tyndall had told them that the resistance depends on the fineness. What Prof. Tyndall said in his lecture was: "Wires are warmed by a moderate electric charge; by augmenting the charge they are caused to glow. The heat developed is proportionate to the square of the quantity of electricity, measured by the unit jar; with a strengthened charge the metal is burnt to pieces, fusion follows, and by a still stronger charge of it the wires are reduced to metallic dust and vapour. For such experiments the wire must be thin. Without resistance we can have no heat, and when the wire is thick we have very little resistance." And that is exactly what I say my scientific witnesses will tell you. It was matter of common knowledge, at any rate after Tyndall's lecture, that the smallness of the section of the wire, whatever the material was of which it was composed, governed the resistance. But Lane-Fox did not stop there, because he also describes the means of obtaining light by incandescence of carbon. It is quite true, as Sir Frederick Bramwell pointed out, that he added to his description something that was not very useful, but he does describe this. He says: "According to another method or arrangement for obtaining light by incandescence of carbon, or other suitable material, the said material is enclosed as before described in a glass vessel from which the air is exhausted, or which is filled with any suitable gas, and the terminals are, as before described, fused into the glass at the lower end of the neck, where it is sealed up; or the glass vessel may be made in any way by which it can be readily opened when desired and be again hermetically sealed. One of the terminals leads by a proper conductor to a small piece of hard coke, graphite, or other suitable material." That may be a natural carbon or an artificial carbon provided it is a suitable material and is affixed thereto so as to be in good electrical contact with it. "This piece of carbon or material may be spherical or of any other desired shape." This gives a description of the other terminal leading to the bottom of a long cylindrical vessel containing mercury. I will not read it, because it was read by Sir Frederick Bramwell, and coming from him I am bound to accept it. I do not want to prejudice anything our scientific witnesses may say about it, but Sir Frederick Bramwell said that conveyed to his mind that Mr. Lane-Fox's idea was a semi-arc lamp. Prof. Frankland agrees with that. But suppose somebody had stopped short at line 24.

Mr. ASTON: Then he would have got exactly the thing.

The SOLICITOR-GENERAL: Knowing the necessity of a small sectional area in order to get a high resistance, and knowing that high resistance was necessary for an incandescent lamp. Now let us come to what I think is of cardinal importance in this case, and that is Mr. Swan's patent. Mr. Swan's lamp stands in a very peculiar position, as your lordship will see when I mention the facts. Mr. Swan's lamp was, I think, exhibited three times before the date of Edison's patent. Lectures were delivered at the not very small or unenterprising town of Newcastle-upon-Tyne; these lectures were published, and in them Mr. Swan described his lamp and the way it was worked, and a gentleman will be called who will tell you how Mr. Swan described it. But Mr. Swan did not stop there. Mr. Swan described his lamp after the date of Edison's patent, and Mr. Swan made statements then which I am quite sure he would not have made if he had not believed them to be true. But, my lord, Mr. Swan has been in court throughout this trial. Mr. Swan has been assisting my learned friends.

Sir RICHARD WEBSTER: You have no right to say so.

The SOLICITOR-GENERAL: I will not go beyond this, that Mr. Swan has been sitting on my learned friends' side of the house.

Sir RICHARD WEBSTER: Because there is no room on yours.

The SOLICITOR-GENERAL: I do not know whether that is supporting. I am told sometimes it is not. Mr. Swan has been in Court throughout the hearing of this case, and he might have been called. Sir Richard Webster opened this part of the case, if he will allow me to say so in his presence, in a most candid and fair manner. He quite saw the importance of Mr. Swan's lamp, and if Mr. Swan had been able to say that he did not get his carbon in the way which they now try to make out was of so much importance, it would have been perfectly easy to have called Mr. Swan; if Mr. Swan did not make his carbon by cutting a strip of paper and charring or carbonising it, it would have been very easy to have called him to say so. Mr. Swan might have been called to explain to your lordship that that lamp is not an anticipation of Edison's; but he was not called. I do not say that my learned friend did not exercise a wise discretion; but your lordship knows from the name of this company that Mr. Swan and Mr. Edison have put their horses together. I hope I am not doing Mr. Swan an injustice in saying that his name has been used by the company with his consent, and Mr. Swan and Mr. Edison hope, I suppose, by putting their horses together to secure for themselves that monopoly which neither of them could have secured for himself. I am surprised, having regard to the importance which it was known was attached to Swan's lamp in this case, that Mr. Swan was not called to give the information which he, I will not say alone, but which he certainly and primarily could have given. His lectures have been put to a witness, and if Mr. Swan was prepared to say that anything in those lectures was said by inadvertence, or otherwise was not correct, he might have been called to say so. If Mr. Swan had made statements which he could not substantiate in any one of his pamphlets to which reference has been made, Mr. Swan would have been the first person to have come forward and said so. But we have not had the advantage of hearing him. I rely very much upon what I am instructed my witnesses will say Mr. Swan did say as to the character of his lamp. Let us take his lamp according to my learned friends' own description of it, and see whether it is not an anticipation of Edison's. I told your lordship that Sprengel's pump had been invented, which was a great step. Mr. Swan availed himself of that, and he made his lamp in the form of a glass bulb—I hope I am not wrong in calling it a bulb—through which he passes his wires, fused into the glass, and which he exhausted by means of the Sprengel pump. The wires were of platinum; they were connected with a carbon conductor. Of that there is no doubt. The carbon conductor was a thin pencil. Your lordship has seen it, and you will be able to say whether I am correct in describing it as a thin pencil. I am not going into twenty-fifths or thirtieths of an inch; all I say is that it was a thin pencil—so far as I can judge with my eye, and not being particularly experienced in judging of size, about the size of the lead of a rather fine lead pencil. It would be somewhere about the size, for instance, of one of Mordan's H leads, which we put into our pencil cases. That lamp, your lordship will be told by my witnesses, was lighted up at two of the lectures and was apparently successful, and was only put out when the lectures were concluded. If you substitute the word burner for filament in Edison's second claim then you have the description. Mr. Swan's lamp was not a success; and why? It was not a success because he found that there was a sooty deposit, and he could not make out what it arose from until he hit upon the happy idea (and it shows that he was a man of great powers of discovery) that it arose from the occluded gases in the carbon which were set free by the heat of the carbon conductor when the current of electricity was passed through. It is quite true that Edison had discovered that before, and Edison had described the means by which you could get rid of those occluded gases in the way which, Mr. Imray told me after some hesitation, was the way in which Mr. Swan afterwards endeavoured to do it, by applying that process, by running the pumps and getting rid of the occluded gases. Your lordship knows what it is. Before the air is fully exhausted you pass a current of electricity through the thing so that it lets out the occluded gases, which go off in the exhaustion pump. If you apply that you have as good a lamp as ever was made. So my witnesses will tell you, and I have not heard one single witness say the contrary. I want, in the last ten minutes of the day, to put your lordship in possession of what seems to me the cardinal and vital point of this part of the case. If you substitute the word "burner," or "fine burner," for the word "filament" in Edison's second claim no one can deny that would be bad for want of novelty. But, my lord, does that word filament make any difference? I submit not. We have it from Dr. Fleming that there was no novelty in making a carbon filament by carbonising a thread of any fibrous substance. I say, what is a filament? My learned friends will say, this is not for carbon burners generally, but for carbon filaments; and the answer is that that is only a particular kind of carbon burner, and if all the world had the right to use carbon burners before Edison's patent, that included the right to use carbon filaments. That is to say, carbon burners included carbon filaments. Now, my lord, what is a filament? I am not going to cite authorities at this remnant of the day, but I will give plenty of authority with which Mr. Aston is acquainted, and which I am sure he will not controvert. I will state my proposition again. I say, if all the world have the right to use carbon burners in a lamp of this description, that includes every kind of carbon burner. Observe that if a man invents a new means for making a carbon filament or a carbon burner at any time he can patent that undoubtedly. Nobody denies that. But you cannot have a patent for a particular kind of carbon burner in which there is no novelty *per se*—or rather of a lamp containing a particular kind of carbon burner—for all the world are at liberty to use carbon burners. Well, my lord, what is a filament? We have had various definitions of it, and my learned friend Mr. Aston read a definition from the Imperial Dictionary. It was stated that it was a fine thread, and again, as an illustration, that it was a thread well known in botany and in anatomy. I dare say it is; but it means a thread; a fine thread, if you please; that is to say, the distinction which makes the thing a filament is the fineness of the size of it. It may be that a fine thread has also—it depends—the advantages of elasticity and flexibility. I do not know why there should be elasticity unless the substance of which it is made is elastic, but that is an accident. What makes it a filament is the smallness of its size, and the elasticity may vary from practically that of an unelastic material to a most elastic material such as India-rubber, or any other substance which we call elastic. Flexibility may vary from almost complete rigidity down to the flexibility of a piece of silk, or a similar substance of that kind. I do not find in either of the dictionaries that flexibility or elasticity enters into the definition of a filament, nor do I find in Edison's patent that his filament is to possess any particular amount of flexibility or elasticity, nor that he has selected as the materials for making the filament those materials which possess in the highest degree the qualities of elasticity and flexibility. On the contrary, he tells us that a wooden splint, which is one of the least flexible of materials, at any rate very much less flexible than most materials, may be used. He does not tell you that you are to select by preference articles which are by their nature in possession of a high degree of elasticity and flexibility. But, my lord, be it so. King told us we could use carbon conductors. Roberts told you the same thing. Swan does use carbon conductors. Lane-Fox tells how to get a successful lamp, and Tyndall gives you the scientific law. Lane-Fox tells you that to get a successful burner you must have high resistance, and that to have high resistance you must make it as small as possible. What could have prevented Mr. Swan from taking out his thin pencil or wire or whatever you like to call it (for it seems to me not a question of words but of things) and putting in a carbonised thread, an article which was extremely well-known, Dr. Fleming told us? He had the right to use any carbon burner. What was there to prevent him reducing the size of his carbon conductor from one size to another? These may be discoveries, but is there invention, and can a man have a patent for telling you that if you use or make a particular part of a machine smaller, for that is all it comes to, you will derive particular advantages, when all the world has the right to use the machines? It may be that it makes all the difference between its success and non-success. I quite agree in that. But that does not make it a subject for a patent, nor does it give it novelty. Suppose Mr. Edison had made this discovery, which he had not, as I shall show by my evidence, that does not make his patent good. You cannot have a patent for giving people the best mode for using a well-known machine, and if Mr. Swan's lamp was published and shown to all the world and was a thing which Mr. Swan and all the world who listened to his very interesting lecture had a right to make, which unquestionably they had, how can you prevent a person from making Mr. Swan's carbon burner of thinner material or substituting any other, there being no novelty in the mode? Edison has told the world that if you make the burner smaller, that which has been done hitherto will be made more beneficial and give better results than people have hitherto obtained by large burners. That seems to me to be the principal part of the case. I have asserted propositions to which Mr. Aston shakes his head, and it will be for me to make good what I have said by reference to the authorities to which I propose to call your lordship's attention.

(The Court then adjourned for the day.)

*(To be continued.)*

## LEGAL.

**United Telephone Company, Limited, v. Bassano and Slater.**—Court of Appeal, Monday. Before Lords Justices Cotton, Lindley, and Lopes. The question in this appeal from Mr. Justice North was whether the telephone made and sold by the defendants, Messrs. Bassano and Slater, of Traffic Street, Derby was an infringement of Mr. Edison's patent, which had become vested in the plaintiffs. The considered judgment of Mr. Justice North was given on March 27th, and was then reported at length in the Review. The main point was with regard to the vibrating diaphragm made use of in the Edison telephone, the defendants contending that in their instrument there was no diaphragm within the meaning of the word in Edison's specification or performing the functions of the diaphragm in his instrument. In Edison's instrument the pulsations of the voice strike upon a vibrating diaphragm, which communicates with the tension regulator, the diaphragm being between the speaking tube and the tension regulator. The defendants placed their tension regulator at the base of a speaking tube, which was attached to a board, to which the wires for conveying the electric current were fixed. The plaintiffs maintained that the board was in fact a diaphragm within Edison's specification, and performed the part played by the diaphragm in his instrument. Mr. Justice North having held that the defendants had infringed the Edison patent, the defendants appealed. The defendants said they could construct their instrument without the vibrating board, and asked the Court, in the event of the judgment of Mr. Justice North being upheld, to decide whether they would still be infringing the Edison patent if they omitted the board.

Mr. Bigham, Q.C., Mr. Aspland, and Mr. Claud Plumptre were for the appellants; Mr. Aston, Q.C., Sir R. Webster, Q.C., Mr. Moulton, Q.C., Mr. Micklem, and Mr. Dove for the respondents.

The hearing of the appeal was begun last Friday and concluded on Monday.

In giving judgment, Lord Justice Cotton said the only question was whether the machine used by the defendants was an infringement of Edison's patent now vested in the plaintiffs. The question was a nice one. The patent was for improvements in telephones, and the essential thing was to have a continuous current of electricity, but varied in intensity from time to time by the pulsations of the voice, so that the current of electricity should reproduce those pulsations at the receiver. This object was attained by means of the tension regulator, and Mr. Edison said he made use of a diaphragm, the vibrations of which acted upon the tension regulator by increase and diminution of pressure. In his specification Mr. Edison gave a general description of his instrument, pointing out the position of the diaphragm, but he did not pretend that this was the only way of acting on the tension regulator. He mentioned other possible diaphragms, and did not confine himself to any particular kind. What he said was:—"I would observe that I do not claim generally the transmission and reproduction of sounds by increasing and decreasing the resistance of the circuit, nor do I claim separately any of the parts or arrangements herein before described and illustrated in the accompanying drawings, except as hereinafter mentioned, but I claim as my invention, first, in an instrument for transmitting electric impulses by sound the combination with a diaphragm or tympan of electric tension regulators substantially as hereinbefore described for varying the resistance in a closed circuit substantially as set forth." The questions therefore were whether there was in the defendants' instrument a diaphragm or tympan whether there was a tension regulator substantially the same as Edison's; and whether there was a combination of the tension regulator with the diaphragm so as to perform the operation described in Edison's specification. What was a diaphragm according to the proper construction of the specification? It was necessary to see whether the word was used as a term of art. The scientific witnesses had not taken the word in any extraordinary sense, but they said that, having regard to the addition of the word tympan and to the terms of the specification, the word diaphragm must be taken to mean something capable of vibrating by pulsations of the air moved by the human voice. Examining the defendants' instrument it was clear that the board acted as and was a diaphragm according to the definition given by Lord Justice Fry:—"The ordinary signification of the word diaphragm I take to be a mere partition or separation—something, as one witness said, which separates something from something else." "United Telephone Company *v.* Harrison, Cox-Walker, & Co." (21 Ch. Div. at page 734.) Was it a diaphragm within Edison's specification? It was startling at first that the board to which the speaking tube was attached should be acted upon so as to vibrate and communicate the vibrations to the tension-regulator, but experiment had proved that such was the case, whether one spoke through the speaking tube or not, and whether the voice was directed to the front or the back of the board. It was clear therefore that in the defendants' instrument there was "a diaphragm." Then was there a tension regulator substantially such as was described in Edison's specification? In his lordship's opinion there was. Edison had mentioned several sorts of tension regulators, but in that which had ultimately been preferred there were fixed blocks and suspended pencils of carbon which acted by varying the tension according to the distance between the carbon points. Substantially the same thing was used in the defendants' instrument though the carbons were fixed to the base of the speaking tube instead of being situated, as in Edison's instrument, on the other side of the diaphragm. In his lordship's opinion, the defendants' instrument was an infringement of Edison's patent, and it was not the duty of the Court to point out the exact particular of the construction to which the infringement was due. The Court would therefore not say whether the defendants' instrument would still be an infringement if the diaphragm was removed.

Lord Justice Lindley, in concurring, observed that the only point of difference between the instruments was that the defendants put their tension regulator between the voice and the vibrating diaphragm, while Edison put his on the further side of the diaphragm. It was no good for the defendants to say that they did not want the vibrating board. The answer was "Then do not use it." In fact, the defendants were using a diaphragm and infringing the plaintiffs' patent. As to whether they would be infringing if they got rid of the vibrating board that question could be discussed when it arose.

Lord Justice Lopes was of the same opinion, and the appeal was dismissed with costs.

## THE STRANGE HISTORY OF A DYNAMO

*As told by itself to*

A. DYNAMICABLE.

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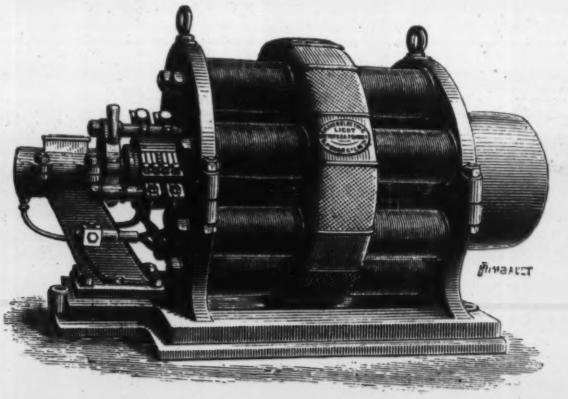
(*Continued from page* 571.)

One of my relatives who has been making considerable headway of late has been dubbed a "Phœnix." Why, I cannot say, unless it is that this *rara avis* has risen from the "hashes" in which an earlier type of dynamo, fostered by members of the tribe of Israel, involved the manufacturers. On the other hand, this signification may have been attached to this scion of our race out of sheer "cussedness," as your American cousins would say, but in any case you may look upon this drawing as life-like.

The armature is a modified Pacinotti ring, and is made up of a number of toothed annealed iron disks strung together, but metallically separated one from the other by varnished paper. These disks are firmly held by insulated bolts passing right through them, the projections of the bolts at each end being firmly attached to gun metal frames or supports keyed on to the spindle which carries the armature.

There are 48 coils wound upon this particular armature, which are all joined up Gramme-fashion to a 48 bar collector.

You think that now I have brought this history up to the present date, the young members of our family appear to be like Cæsar and Pompey—"very much alike, especially Pompey?" Yes, to the uninitiated there is but little to choose so far as external appearances go, but, you know, one should not always judge by appearances.



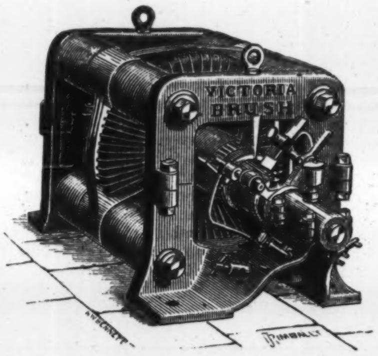
The Gulcher Dynamo.

To look at me you would little think that I am such a departure from any of the rest of us, but I must forbear until my story has ended; you shall then know "what's in a name." Hitherto, since the time of Gramme, I have spoken of those of us having two pole pieces only to the field magnets, these being, with the exception of my Brush form, placed over and under the armature.

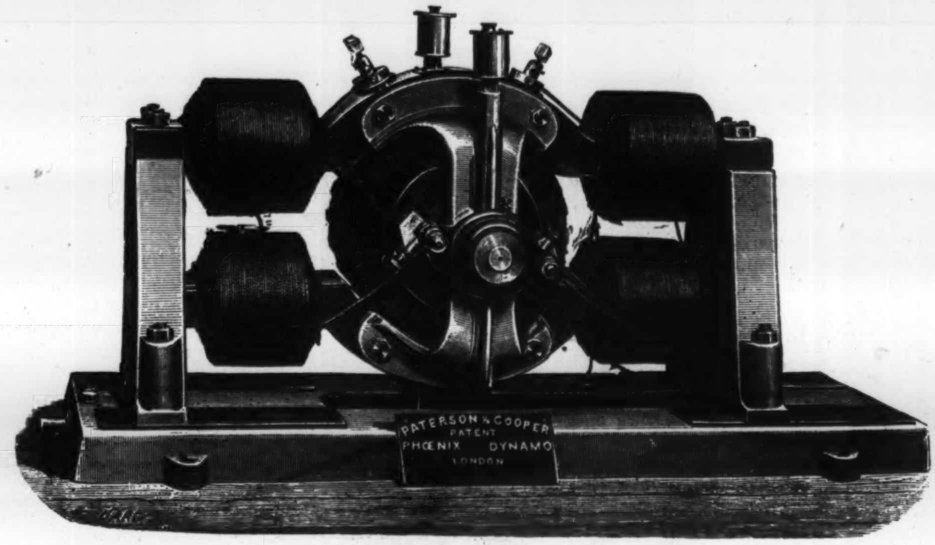
But there are several types of us in extensive employment with multipolar field magnets, the pole pieces of which are arranged alongside the armature ring, which for these purposes is generally made much narrower than that of Gramme or Siemens and may be more generally considered as being like unto a large iron washer. Of this class I will single out for you the "Gülcher" type, so-called after the designer's name. The armature here is constructed with hoop iron coiled upon a gun metal casting, and many improvements in the massing of the iron in both armature and field magnets have been made, so that the output of machines of the latest construction is double that of the earliest, weight for weight. Local heating from "eddy" currents is also almost entirely eliminated and the mechanical parts of the machine improved.

Here, again, the coils are wound and connected to a collector in the manner common to Gramme, Siemens and others, but notwithstanding the fact that the armature revolves in a multipolar field, two collecting brushes only are required. This result is arrived at by connecting up together certain points around the armature called "equi-potential" points. Gülcher machines have been made with 6, 8, and even 12 poles, but they are now reduced to four, and will probably at no distant date come down to two only. To any person desirous of studying my Gülcher form in a quiet sort of way, I would say go to the Crystal Palace, where my multipolar kith and kin can be seen, "far from the madding crowd" which every day surrounds us here.

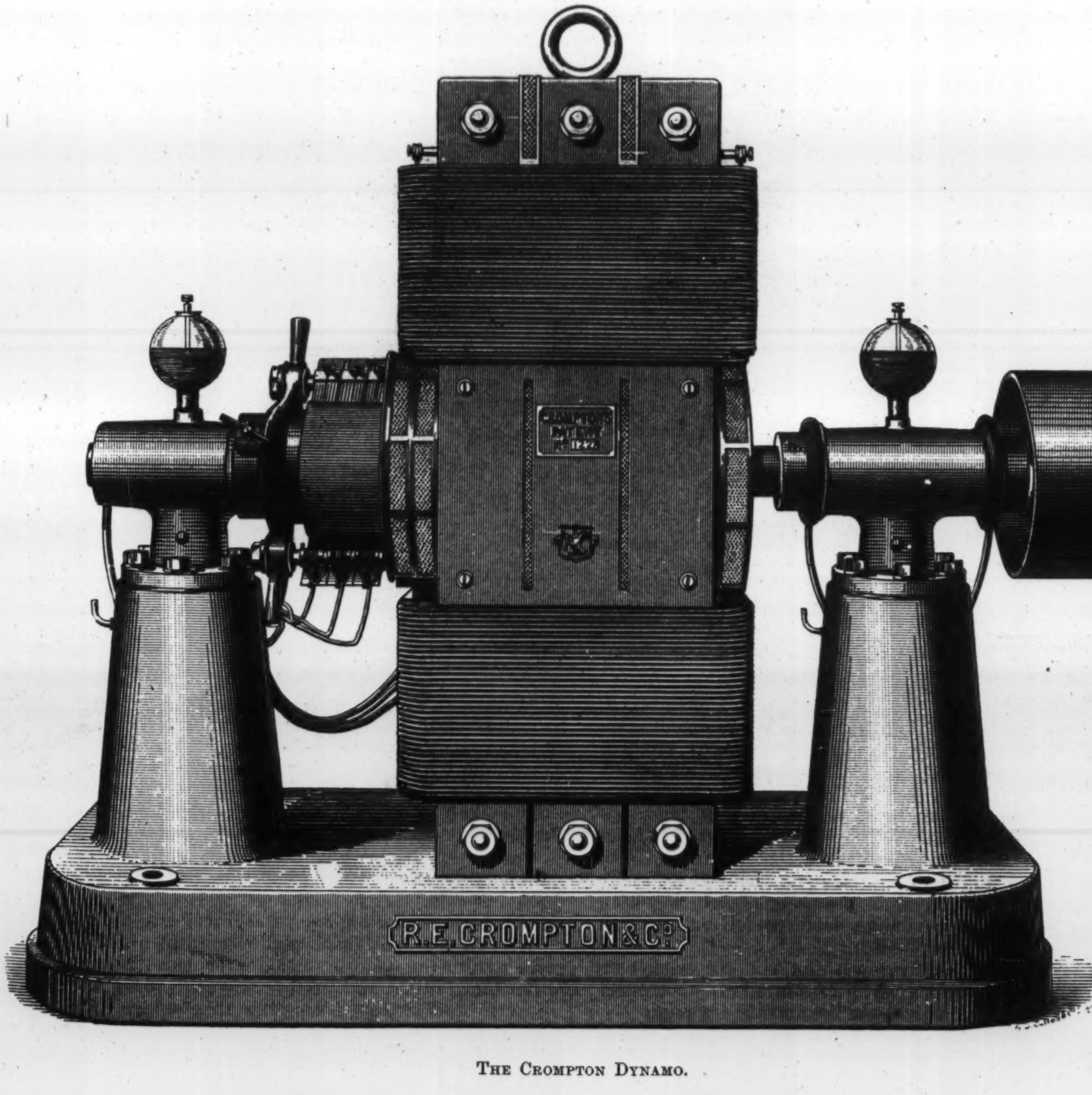
Some years ago a Mr. Schuckert thought he would try his 'prentice hand in dynamo construction, and he devised a form with a flat ring armature and field magnets arranged on each side. This machine met with extended employment in this country under the auspices of the Pilsen-Joel Electric Light Company, but it has since then been taken in hand and improved almost out of its former guise by Mr. Mordey, of the Anglo-American Brush Corporation. The pole pieces designed by Schuckert consisted of hollow iron shoes or cases which occupied a large angular breadth along the circumference of the ring. It has been shown that these wide embracing pole pieces gave rise to detrimental effects in the armature, and Mr. Mordey set himself to work to obviate these defects by making the pole pieces quite narrow, and in this he has entirely succeeded. The core of the armature is built up of hoops cut from sheet charcoal iron, each hoop being carefully insulated electrically and magnetically from its neighbour, and "eddy" currents have almost entirely disappeared. It is, as you can clearly see, not at all unlike my Gülcher form; its armature is of the flat ring type, the field magnets are multipolar, and as the points of equi-potential are also connected together two collecting brushes only are found necessary. This has for some considerable time been popularly known as the "Victoria" dynamo, although its more correct appellation would of course be the "Schuckert-Mordey" machine. It would not be fair to dismiss



The Schuckert-Mordey Dynamo.



THE PHŒNIX DYNAMO.

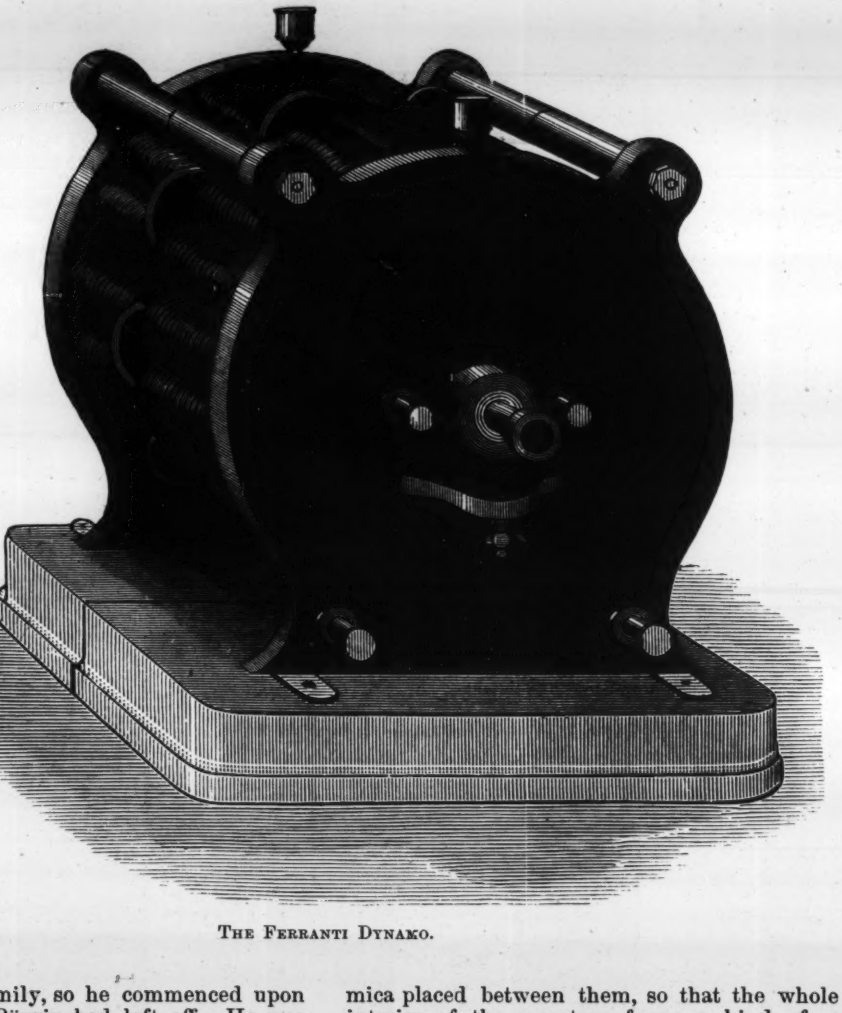

R.E. CROMPTON & Co.

THE CROMPTON DYNAMO.

Mr. Mordey without remarking that he has within recent years done as much as any man living to show experimentally the phenomena underlying our action, and he has thus enabled electricians to clearly see what to select and what to avoid in the construction of a really good and efficient dynamo—like myself, for instance. No, the time has not yet arrived when I can divulge my identity; like certain competitors in pedestrian handicaps I am running under a name which I must for a few minutes longer still "keep dark," although I am anything but a "novice," as you will shortly learn.

Among the many workers in the domain of electric lighting there stands in the foremost rank a Mr. Crompton, who has done wonders towards popularising this important industry. He also must needs think that he could do something to make us a still more numerous and hybrid family, so he commenced upon one of us where a Mr. Bürgin had left off. He was completely successful in his attempts to make my Bürgin form still more presentable, active, and long-lived, for with us you must remember that degeneration of species is as yet unknown. Our motto has been "Excelsior;" but I begin to think that we have almost arrived at the zenith of our powers, or in other words that a state of perfection has been reached which renders further improvement from an electrical point of view almost an impossibility.

Mr. Crompton, however, was not content with outdoing Bürgin, so after a while he started upon another track, the result of which you see in this drawing.



THE FERRANTI DYNAMO.

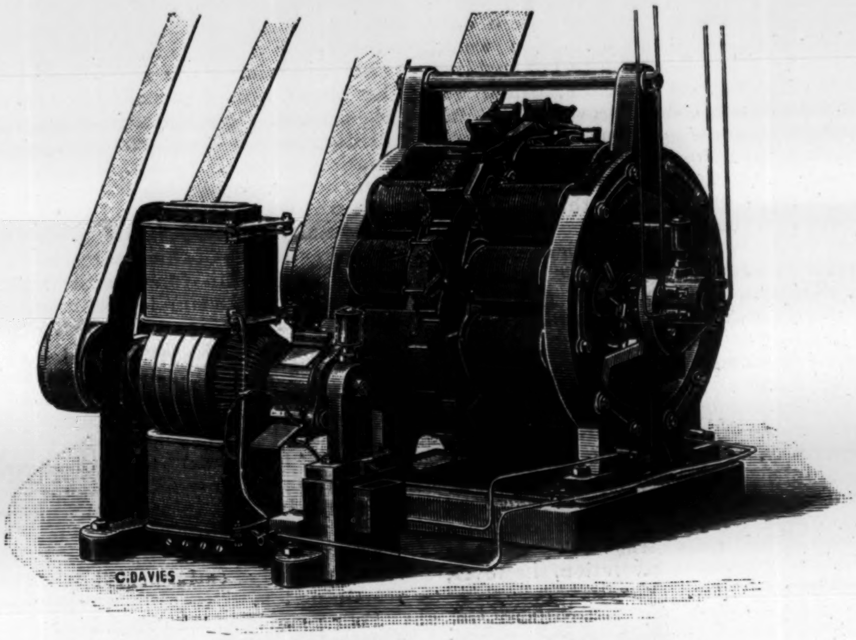
The improvements which have been here introduced have been in so proportioning the parts that the maximum output has been obtained with a minimum weight and cost. The latest form of mounting the armature core on the spindle is as follows: The centre part of the spindle, or that which passes within the armature core, is insulated so as to form a long base, and in this four rectangular grooves are planed. Into these are fitted with extreme care four phosphor bronze radial bars. The taper edges of these radial bars are formed with a dove tail. On these bars the wrought iron armature core is built up by slipping on a succession of thin discs insulated from one another by a patent preparation of an oxide of tin which will stand a very high temperature without impairing its insulating powers.

The radial depth of the core is very great as compared with the diameter. The Gramme-like winding consists of copper bars rectangular on the outside, but of a wedge-shaped section on the inside. They are insulated on the inside from one another by strips of mica placed between them, so that the whole of the interior of the armature forms a kind of grid-iron separated by mica slips, and through which the air can readily pass from the interior to the exterior.

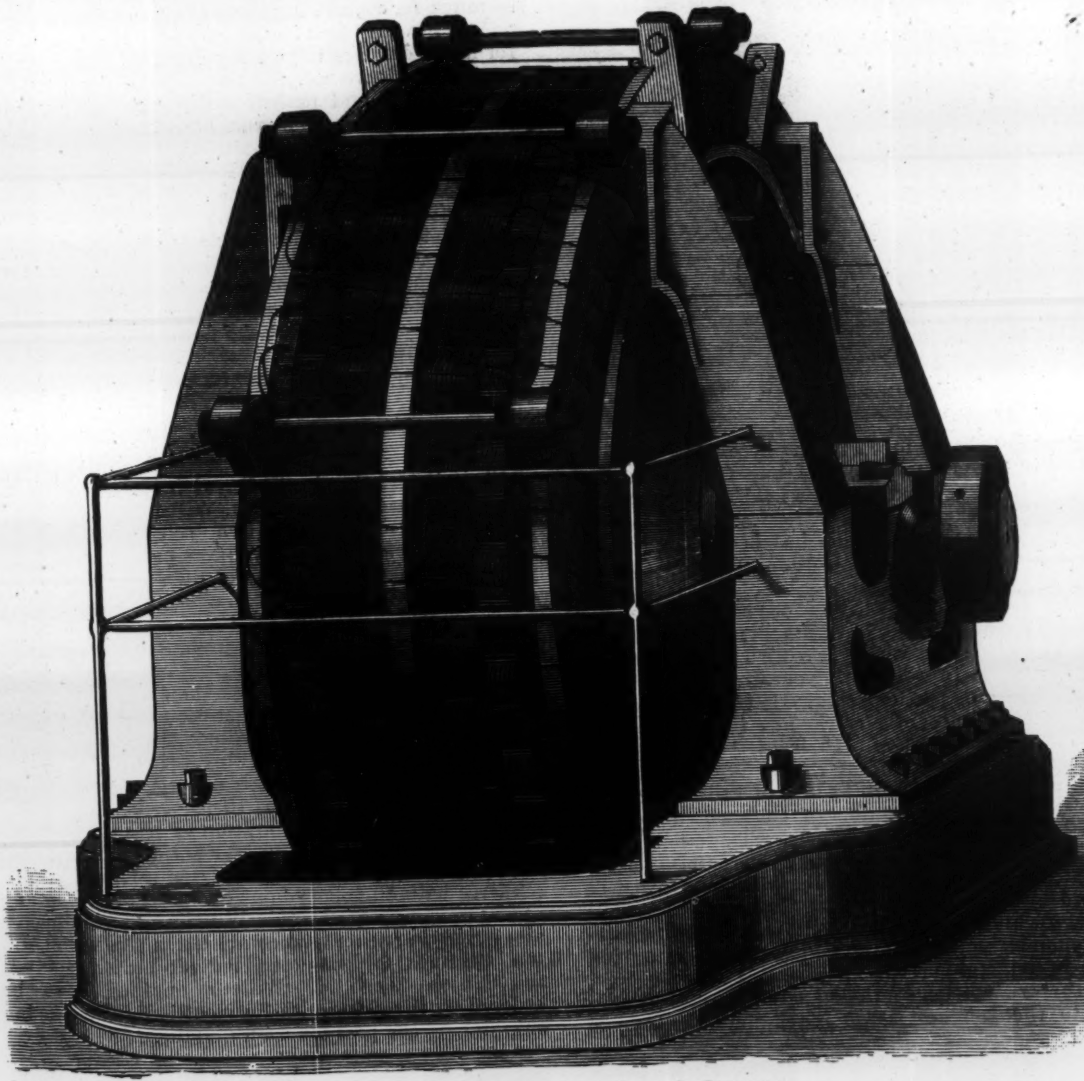
The whole of the surfaces of the conductors is therefore bathed in a continuous stream of air, and thus kept cool.

Several spaces are left in the core as it is built up, and in these spaces distance pieces are placed, so that each space when the armature is revolved can act as a fan, drawing the air from the interior to the exterior.

Every effort has been made to transmit the power direct from the spindle to the outer parts forming the exterior winding, and in this way the great difficulty hitherto met with of keeping this exterior winding firmly in position, when under the influence of a heavy strain, is effected. A machine of the type I show to you, used for depositing copper, has realised 91 per cent. of commercial efficiency in actual work.



THE SIEMENS ALTERNATING CURRENT DYNAMO AND EXCITOR.

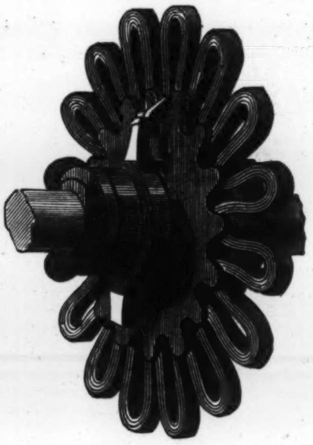


THE GORDON ALTERNATING CURRENT DYNAMO.

I have previously explained to you that my predecessors previous to the time of Pacinotti were only able to produce alternating currents. You would hardly think therefore that when the secret of enabling us to produce currents in one direction, which was the great desideratum, had been discovered, that any one would trouble to improve upon our early forms.

Yet, as I remarked but a short time since, alternating currents have their uses, and after bringing before your notice the principal members of this branch of my family I must bid you adieu. Siemens who has done so much for the present generation did not neglect our forefathers, and by a judicious process of renovation they now present a very spruce and youthful appearance as you may see from this view of one of them. The peculiarity here is that the revolving coils—they cannot be called electro magnets—contain no iron core but are simply wound upon wood. The ends or poles of the stationary field magnets which are placed on each side of the armature approach to within close proximity, so that the coils revolve in or cut through a very intense magnetic field.

Another inventor, Ferranti by name, not only kept the armature free from iron, but made the coil in a zigzag form and in a continuous length, as you see in the sketch I show you; each convolution, however, being insulated from its fellow.



FERRANTI ARMATURE.

I must not omit to mention here that separate *continuous current* members of our family are employed to excite or magnetise the field magnets of my alternating current brethren.

In another of our race which has been reared under the auspices of Mr. J. E. H. Gordon, the iron cores of the revolving coils are retained.

M. Gramme is also responsible for producing another specimen, in which the *field-magnets revolve* inside a stationary iron ring which is coiled with insulated copper wire and in which the currents are induced. Many of us in this particular guise have done yeoman's service in the cause of electric lighting as associates of the Jablochkoff system. In brief, I may say that the armature of nearly all of this type consists, with the exception of the Ferranti form, of a disc carrying at its circumference a number of coils which revolve between stationary electro-magnets. These field-magnets being arranged with the ends alternately magnetised, N and S, the moving coils will necessarily be traversed by alternating currents. The most important advantage which can be claimed for alternating current dynamos is that the *collector*, which is a vital portion of our uni-current members, is not required, and as this is a portion of their anatomy which is subjected to the roughest usage, such an advantage is obvious.

One other point and I have done. In a sketch which I made for you about the time when we were discussing Pacinotti and Gramme, you noticed that the armature, the field-magnets and the external circuit, *i.e.*, the electric lamps, were all connected together in series or in a simple circuit. This method of connection is unsuitable for many purposes and therefore it has been proposed to make the magnet coils a shunt to the armature, in other words, the magnet coils form a distinct circuit in themselves from the collecting brushes, which has nothing in common with the external circuit.

A still better method, and one which is now almost universally adopted, is to coil the field magnets with two circuits, one of thick wire, the other of thin. The thick wire circuit forms with the armature and the external circuit, a simple circuit, as shown in the sketch to which I have just referred, but the fine wire is wrapped over the thick coil and forms a shunt to the main circuit. This system of coiling is called "compound" winding, and the influence which the thick and thin coils respectively exert upon the magnetism of the field enables us to regulate ourselves automatically to the exigencies of the situation. As an example, one of my neighbours is now giving current for supplying 300 incandescent electric lamps; these can be turned off in batches without in the least interfering with the action of the rest; indeed, 290 may be simultaneously extinguished without affecting the remaining ten.

Four years ago such automatic regulation as this was a sheer impossibility, although the first mention of this compound winding may be found in a patent granted to Mr. S. A. Varley, the man who had previously done so much for us, as long since as the year 1876.

And now my task is almost ended. It but remains for me to disclose to you my identity. I am loth that you should leave me, for the opportunity of securing so interested and patient a listener has never before fallen to my lot; but, you know, the best of friends must part, and there remains the consolation that we may meet again anon, for I am likely to be a fixture here for some time to come. And now, before my final adieu, to communicate to you who and what I am. Listen—these are my names, bear them well in mind, for the combination indicates the perfection which is found in me alone of all my race: remember me, then, as——

(*To be concluded in our next.*)

## NOTES.

**Electric Lighting in the Royal Navy.**—The Admiralty has just ordered from Messrs. Willans and Robinson, of Thames Ditton, twenty-two sets of engines and dynamos, mounted upon Willans combination frames, for lighting cruising vessels of the smaller classes. In the eleven ships, viz.: the *Archer*, *Brisk*, *Cossack*, *Porpoise*, *Tartar*, *Mohawk*, *Fearless*, *Rattler*, *Wasp*, *Bramble* and *Lizard*, for which the twenty-two sets are intended, the internal lighting of the vessel is to be done by electricity as well as the search lighting, and the Admiralty determined that economy in steam consumption, and proved freedom from accident and trouble in continuous running, should govern the selection. The Willans engine, coupled in every case to a Siemens dynamo, has therefore been chosen, and it is believed that a consumption of less than 35 lbs. of water per electrical horse-power is likely to be attained, even in these small sets. The dynamos are to give 100 ampères with 80 volts, some at a speed of 400 and some at 650 revolutions. Messrs. Willans and Robinson are also supplying seventeen combination sets with Crompton dynamos, for sea-going torpedo boats. Including these, more than 100 Willans engines have been ordered by the Admiralty for electric lighting on board ship during the past fourteen months.

**Proposed Electric Lighting at Birkdale.**—Intending contractors for this work are reminded that tenders have to be sent in by July 24th.

**Electric Lighting at Eastbourne.**—The Law and Parliamentary Committee of the Town Council is desirous of obtaining estimates for the requisite electric light and gas fittings for the Town Hall building. Persons willing to tender are to send their names to the architect, Mr. W. T. Foulkes, 100, Colmore Row, Birmingham, by 15th July.

**The Colchester Electric Lighting.**—Says *Gas and Water*:—"Colchester is happy at last. If the Colchester Electric Light and Power Company, Limited, 'does not make the electric light a success financially, it intends to make the light a success.' So spoke Mr. Paxman at a special meeting of the Town Council on the 16th inst. We wonder what the shareholders will think of this policy. The company, it is said, is purely a local one, consisting of natives and friends of the town; but even patriotic love cannot long hold out against an empty pocket. Mr. Paxman's policy has, however, an ulterior motive. If the light is made a success the people will gradually adopt it, on account of its 'extreme cleanliness and healthful character.' That may be so; but 'How long?' will be the question the shareholders will naturally ask—how long until the light is made a success, and the purses of the noble band of patriots filled with something more than scientific zeal and patriotism to Colchester and the electric light! The company has now, however, received the sanction of the Town Council to the transfer of the license of the South Eastern (Brush) Lighting and Power Company, Limited; and it can, therefore, proceed to make the light a success with all despatch. Some hint was thrown out at the council meeting that the company was to enter into active competition with the gas company, but this idea was energetically refuted by the friends and supporters of the Electric Light Company. According to Mr. Paxman the gas company has one hundred and one other ways of making a livelihood besides supplying gas for the illumination of the town. This we are not inclined to deny, but we wish to point out to Mr. Paxman and others that, unless the Electric Light Company makes haste towards success, the gas company may yet continue in the happy possession of one hundred and two ways for the disposal of its manufactures. The pioneer company in Colchester failed to show the people the advantages of the electric light; and unless the new company can submit a more cogent argument than the bare statement that 'we are brothers,' it may find the people of Colchester hard to convince."

**Telephonic Experiments.**—A short time since Mr. H. F. Lewis, of the Western Counties and South Wales Telephone Company, established telephonic communication between Bristol and London, a distance of 118 miles. The conversation which passed was perfectly audible, and the experiment in every respect proved a success.

**The "New" Telephone.**—Last week the New Telephone Company, Limited, completed the fixing of the telephone to Mr. W. Walker's Mills, Trowbridge, whereby the four mills in different parts of the town are now all connected. The entire arrangements have been carried out by Mr. Samuel Diplock, engineer, of London and Trowbridge, who, we understand, has other contracts to carry out under the same system.

A meeting of business men was held on the 24th ult. at the Manchester Cotton Waste Exchange to consider the charges of the Lancashire and Cheshire Telephonic Exchange Company. It was stated that subscribers had two grievances—firstly, that the present subscription of £20 was too much; and, secondly, that the company was now enforcing an additional subscription of £1 1s. per year for the use of the telephone boxes on the Exchange. The formation of a new company on the system of Professor Silvanus Thompson was suggested by the chairman, Mr. George Hahlo. A committee was appointed to lay the views of the meeting before the directors of the company, and to take such action as was necessary.

**Relative Rates of Telephonic Service.**—In the *Statesmen's Year Book* figures are given which show that the Government of England operates 27 exchanges, comprising 1,142 subscribers, and the gross annual revenue is £22,600, or nearly $100 each. For exchanges occupying similar territory in the United States, according to our New York namesake, the average rental per subscriber is $60 per annum.

**Opening of a Telephone Exchange at Southampton.**—Last week the Western Counties and South Wales Telephone Company opened an exchange at Southampton, which should prove of great benefit to the commercial men of the town. Mr. H. F. Lewis explained that the company was sole licensee for that district of the United Telephone Company, and had the exclusive use of the master patents. In London, Liverpool, Manchester, and Glasgow the rental charged was £20 per annum; in Bristol and several other large towns it varied from £15 to £16; and in Plymouth, Portsmouth, Bournemouth, Torquay, and Bath, £10, which was for a seven years' agreement. It had been decided to base the charges at Southampton on the commercial system which would give them day and night service. The charge for one year would be £14, for four years, £13 per annum, and for seven, £12 per annum. The domestic or day service only would be inaugurated that day, the Exchange being opened, Sundays excepted, from 9 a.m. to 6 p.m. at charges of £12 for one year, £11 for four years, and £10 for seven years, the agreement applying to a one mile radius. Free communication would be provided with the chief police station, the central fire brigade station, and the Royal South Hants Infirmary, and if a large number of subscribers were ultimately obtained they might connect the Exchange with Portsmouth, Bournemouth, and other places, including perhaps London. The United Telephone Company now had about 40,000 instruments at work in the country. The Exchange was then opened, and Mr. C. Goldstone, superintendent electrician of the London and South Western Railway Company, said that conversation could be carried on between Southampton and London with the greatest ease. The working of the system was thoroughly explained to the company, who did not separate without drinking to the success of the new venture.

**The Telephone at an Agricultural Show.**—During the annual show of the Royal Counties' Agricultural Society which was concluded at Portsmouth on Monday, a wire was erected connecting the show yard with the local exchange, and proved a source of great convenience to the local exhibitors who were enabled to speak through to their business establishments, and to many visitors who wished to make enquiries.

**Telephonic Communication between Bournemouth and Poole.**—Trunk lines have recently been established between Bournemouth and Poole, which are open to the numerous subscribers to the exchange. The latter is now established on a satisfactory footing.

**The French Cable Company.**—It is stated that at a meeting of the French Cable Company, held in Paris last week, the shareholders voted by a majority of 647 against 440, not to accept the accounts submitted, and also refused to re-elect the three retiring directors, and requested the entire board to resign. This, however, the board refused to do, and it is believed that the differences between the board and the shareholders will now be referred to the courts.

**The Proposed Cable between Australia and Canada.**—A Reuter's telegram from Ottawa states that instructions have been sent by the Dominion Government to Sir Charles Tupper, the High Commissioner for Canada in London, to confer with the Australian Agents General concerning the establishment of cable communication between Australia and the Canadian Dominion, and to ascertain the amount of the annual subsidy which the colonies would guarantee.

**The Reduction in Cable Rates.**—The Direct Spanish Telegraph Company announces that the following rates have been reduced:—To Spain, 4½d. per word; to Portugal and Gibraltar, 5½d. per word; and to Senegal, 2s. 10½d. per word.

**The Originator of Atlantic Telegraphy.**—An article in "Representative Canadians: a Cyclopedia of Canadian Biography," seems to establish pretty conclusively that to Mr. F. N. Gisborne, and to him alone, is due the credit of first suggesting, and, in fact, of originating trans-Atlantic submarine telegraphy. The Hon. Joseph Howe, in a letter to Mr. Gisborne, dated February 12th, 1867, when he was Secretary of State for Canada, says: "Without desiring in the slightest degree to undervalue the services rendered to civilisation by the body of eminent men who have just been rewarded for laying the Atlantic cable, I own to some feeling of disappointment in not seeing any mention made of your name, as I have reason to believe you were the first pioneer of the enterprise as well as the original promoter of electric telegraphy in the Maritime Provinces. . . . In 1850 you discussed with me, and subsequently laid before the commissioners a plan for connecting Newfoundland with the Continent of America, and obtained leave of absence to enable you to go to that island and secure support to the project. . . . On your return you asked leave of absence to go to New York to promote an extension of the line to England, and spoke confidently of being able to extend it across the Atlantic and connect Europe with America. . . . As the original pioneer and projector of this great work, it appears to me that you ought to place yourself in your true position, and that if not included among those who are to be honoured and rewarded, you should at least endeavour to obtain from your countrymen and from the world at large, who are to be benefited, the recognition which you deserve as the originator and practical prime mover of the great enterprise now so happily brought, by a combination of public-spirited and able men, to a fortunate consummation." Mr. Gisborne, during the visit to New York, spoken of in the letter, for the first time met Cyrus W. Field, then a licensed junk dealer and well-to-do dealer in rags, and succeeded in interesting him in the scheme with which the great capitalist afterwards became so closely identified.

**The South Australian Postmaster-General.**—Mr. C. Todd, C.M.G., Postmaster-General and Superintedent of Telegraphs of South Australia was entertained at a banquet, organised by the members of the Post and Telegraph Department, on his return from England.

**The Telegraph in India.**—A telegraph office has been opened in the native city of Aurungabad, about two miles from the military cantonments. The line, it is said, is to be extended to Jalna, 40 miles, when funds are available.

**African Telegraphy.**—Mr. Bertram Sparhawk writes to the *Scientific American:* The system of sound telegraphy used by the people living on the border of the Gulf of Guinea, West Africa, is of interest as a primitive solution of the problem of communication through short distances. The instrument is made as follows: Take a log of hard wood, about two feet long and about a foot in diameter. Plane off one side longitudinally to a surface four or five inches wide. In the centre of this surface mark off an elongated and somewhat distorted Greek cross. The longer arms are placed longitudinally, and occupy about one-third of the plane surface. The transverse arms are three times as broad, and extend entirely across this surface. The natives dig out the wood within the outline of the cross, and from there gradually hollow out the whole log. The sides, beginning at the centre, are trimmed off laterally toward the ends, which are rounded off. The instrument is now ready. It will be perceived that by the method above described we have a hollow drum with four tongues in the centre, each being of a different thickness, so as to produce a different sound when struck. Two pieces of bamboo, the size of a man's wrist and about two feet long, are selected and stripped of the hard outside, which leaves the soft, pithy portion for use. This bamboo is of a peculiar kind, free from knots and solid throughout. With these sticks, used in a proper manner on the four tongues of the drum, a combination of sounds is produced which, in connection with time as used in music, forms a perfect telegraphic language, readily understood by the initiated the air being the transmitter. With this simple instrument the natives of the Gulf of Guinea readily communicate with each other for a distance of a mile at least on land and a much longer distance by water. Messages can be sent long distances in a short time by parties at different points passing them along from one to the other. The writer has seen canoes coming down a river from the bush markets signalling people in the town, and giving and receiving general news at a distance of fully three miles.

**Another Inventor of Telegraphy.**—Mr. L. Goldenberg, of New York, writes to the *Scientific American:*—"The 17th of last April was the centenary of Baron P. J. Schilling, the inventor of the electro-magnetic telegraph, born in Revel, Russia, 1786. His first experiments with copper wire as electrical conductor were begun in 1810. In 1812 he successfully exploded a mine across the Neva, by means of an electric current. The same experiment was publicly repeated in 1814 on the Seine at the triumphal entrance of the Russian Czar Alexander the First into Paris. In 1815 Baron Schilling began to investigate the action of electrical currents on a magnetic needle, and in 1820, after numerous experiments, he constructed the first electro-magnetic telegraph. The Czar Nicholas, inspecting the invention at the house of Baron Schilling, had written on a piece of paper, 'Je suis charme d'avoir fait ma visite a M. Schilling,' and these words were afterwards transmitted by telegraph without any mistake. In 1837 Baron Schilling received an Imperial order to connect St. Petersburg and Cronstadt by a telegraph line; unfortunately, the inventor's untimely death—25th of June (7th of July) of the same year—prevented the realisation of this plan. Baron Schilling's contemporaries, as it so frequently happens, were entirely unable to appreciate his great invention; so, when, explaining it before a scientific committee, he proposed to hang the wires on poles, his plan was received with laughter and derision: 'Your invention is pure nonsense, and your *airy* wires are truly ridiculous.' Such was the answer from the scientific body."—*Translated from the Russian journal, "The Universal Illustration."*

**Telegraph Linemen.**—The editor of the *Telegraphist* writes: "Having heard a report that good linemen, with 20 or 25 years' experience, were not allowed to apply for inspectorships, we consulted an eminent authority, who contradicted the statement, and informed us that linemen were eligible for such appointments, and the only reason why few were made inspectors was in consequence of the scarcity of vacancies. There are only a certain number of inspectors in the service, and while they live or do not care to resign, the linemen cannot get the appointments. If any lineman can refute this statement, we shall be pleased to give his case careful attention."

**New Catalogues.**—Messrs. Gent & Co., of Leicester, have sent us a copy of their new catalogue, containing practical instruction as to the fixing and repairing of electric and pneumatic bells and details of electric lighting and telephones. Mr. H. F. Joel has also forwarded one of his illustrated catalogues of electric light requirements, which comprises description and prices of his engine-dynamo and motor, the Pilsen arc lamp, the Joel semi-incandescent lamp, accumulators, measuring instruments, &c.

**The Electrical Supply Company of Chicago.**—We have just received a copy of a useful pocket edition of Tables showing the diameter, weight, resistance and conductivity of some of the wires made by this company at the factory at Ansonia, Conn., with other tables of interest to electricians.

**Electric Locomotion.**—*Invention* states that experiments are being made at the Schwartzkopff works in Berlin with a new electric tramway car. The batteries are placed before and behind the platform, and take up little space, so that there is plenty of room for standing. The car has eight wheels, which circumstance is a disadvantage in passing curves. The trials so far have had good results.

**The Royal Holloway College.**—This college was opened by Her Majesty the Queen on Wednesday, in brilliant weather and under most favourable auspices. An engraving of the key presented to Her Majesty for the occasion has been sent us by Chatwood's Patent Safe and Lock Company, Limited, by whom it was manufactured; it is a fine example of the locksmith's art, the stem and bit being of gold, and the top of the stem being encircled by two rows of diamonds. The bow, which is also of gold, is attached to the stem and supported by two pairs of gold wings, set with diamonds and beautifully chased. About 300 diamonds altogether are employed in the decoration of the key.

**All on Account of the Electric Light.**—An extraordinary riot took place in the Bull Circus in Nimes on Monday. A grand performance by the electric light was announced, and 30,000 persons paid for admission. During the evening the light repeatedly failed, and the audience, becoming exasperated, tore up the benches and furniture, and made a bonfire of them in the arena. Troops were sent for, and after some trouble cleared the building. Several persons were wounded and many were arrested.

**The Society of Telegraph Engineers and Electricians.**—The *conversazione* given to the members of this society by the President, Prof. D. E. Hughes, F.R.S., and Mrs. Hughes, was successfully held in the galleries of the Royal Institute of Painters in Water Colours on Tuesday evening. There was a very numerous attendance. including a large number of ladies. The band of the Coldstream Guards during the evening played a selection of music. Amongst those present we noticed the following:—Lord Alfred Churchill, Count Victor Wimpffen, Sir James Crichton Brown, F.R.S., Sir James Ramsden, Sir Henry Thompson, F.R.C.S., Sir Henry Mance, C.I.E., Sir Charles Bright, Sir Samuel Canning, Sir Frederick Abel, C.B., F.R.S., Sir James Linton (President R.I.); Admiral Sir Edward Inglefield, C.B., F.R.S.; Captain Sir George Nares, R.N., K.C.B., F.R.S.; Major-Gen. E. R. Festing, R.E., F.R.S.; Major-Gen. C. E. Webber, R.E., C.B.; Major-Gen. J. T. Walker, F.R.S.; Colonels Stotherd, R.E., Sir Francis Bolton, Granville Paget, Harrison, C.B., R.E.; Majors R. Y. Armstrong, R.E., J. G. B. Stopford, G. E. C. Beresford, R.E., McGregor, R.E.; Captains H. R. Sankey, R.E., C. A. McEvoy, Douglas Galton, C.B., F.R.S., F. R. de Wolski, R.E., H. J. Holden, R.A.; Lieut. Anstruther, R.E.; MM. E. Hospitalier, Gaston Roux; Herr Hofmeister; Professors G. G. Stokes, (President R.S.), J. C. Adams, LL.D., F.R.S., G. T. Bonny, F.R.S., Vernon Harcourt, F.R.S., G. D. Liveing, F.R.S., A. S. Herschell, F.R.S., Roberts-Austen, F.R.S., W. G. Adams, F.R.S., W. E. Ayrton, F.R.S., John Perry, F.R.S., G. C. Foster, F.R.S., A. W. Reinold, F.R.S., A. B. Kempe, F.R.S., J. A. Fleming, M.A., D.Sc., George Forbes, F.R.S.E., Silvanus Thompson, F.R.A.S., F. Guthrie, F.R.S., W. N. Stocker, M.A., E. Ray Lankester, LL.D., F.R.S., A. J. Bernays; Drs. Hugo Müller, F.R.S. (President Chemical Society), Benjamin Ward Richardson, F.R.S., E. Frankland, LL.D., F.R.S., John Rae, F.R.S., J. H. Gladstone, F.R.S., J. Hopkinson, F.R.S., R. Quain, F.R.S., H. J. P. Sprengel, F.R.S., M. J. Jackson; Messrs. J. W. Swan, W. Crookes, F.R.S., Latimer Clark, Willoughby Smith, C. E. Spagnoletti, W. H. Preece, F.R.S., E. Graves, W. T. Ansell, R. E. Crompton, Alex. Siemens, A. Stroh, Lant Carpenter, Gisbert Kapp, John Munro, C. H. B. Patey, J. Farquharson, E. Cowper, Conrad Cooke, C. H. W. Biggs, H. R. Kempe, S. M. McGowan, H. G. Erichsen, J. Wimshurst, Trueman Wood, C. W. Vincent, P. W. Willans, R. von F. Treuenfeld, F. Despointes, D. Fitzgerald, H. Clifford.

**Self-Induction.**—We have received just as we are going to press a critique by Prof. H. F. Weber, of Zurich, of Professor Hughes's second paper on "Self-Induction." This critique we shall publish in our next issue.

**Removals.** — Messrs. Henry F. Joel & Co. have removed from Tower Chambers, Moorgate Street, to 31, Wilson Street, Finsbury. The new address of the Edison and Swan Electric Light Company is 13, not 14, Albert Mansions, Westminster.

**Sale of Electrical Plant.**—On Wednesday, Thursday, and Friday next Messrs. Wheatley Kirk, Price and Goulty will conduct an important sale of high-class plant and fittings, the surplus stock of the Edison and Swan United Electric Light Company; to be sold consequent upon the removal of the manufacturing department from Newcastle to London, and the change of address of the offices from Holborn Viaduct to 13 (not 14), Albert Mansions, S.W. The sale will include boilers, engines, dynamos, electroliers, and installation fittings of a high class, and well worth the attention of electricians, shipowners, and others.

**New Cable.**—The West African Telegraph Company has received a telegram announcing the successful laying of its lines to Sierra Leone, where a station is now open. The rate for messages from London to Sierra Leone is 6s. 9d. per word.

**Telegraph Revenue.**—The telegraph service produced during the quarter ending September 30th, 1885, £490,000, against £485,000 in the corresponding period of the previous year; during the quarter ending December 31st, 1885, £410,000, against £430,000; March 31st, 1886, £395,000, against £405,000; June 30th, 1886, £425,000, against £445,000. For the year ending June 30th, 1886, the receipts were £1,720,000, against £1,765,000 for the previous year, a decrease of £45,000.

**The Electric Light on the Dining Table.**—The Royal Botanic Society held its annual *fête* at the Society's grounds, Regent's Park, on Wednesday evening last, when Messrs. Dick, Radcliffe and Co. exhibited a dining table lighted by electricity, the current being supplied from a new primary battery. The table was tastefully arranged, with a pond in the centre, with fountains playing, around which were real water lilies floating and carrying small electric lamps; the spray falling about the lamps gave a very pleasing effect. In the grotto were very small 2-volt fairy lamps distributed in the moss, giving a glow-worm effect. All the electrical arrangements were carried out by Messrs. Shippey Brothers on behalf of Messrs. Dick, Radcliffe & Co.

**Woman! lovely woman.** — Some little time ago, states the *Electrical World*, it was rumoured that efforts had been made to get early information, for stock-jobbing purposes, of Secretary Lamar's decision on the question of ordering suit against Prof. Bell's patents. Circumstantial revelations are now made in regard to a pool formed for bearing Bell stocks on the strength of the "tip," and it is said that the scheme failed because "the Boston people, who held the bulk of the stock, immediately made arrangements to tighten their hold on it." It is now alleged that there was a leak in the Interior Department, and that "the mistress of a prominent man in Washington" was in the case.

**To be Noted.**—The petition presented for the liquidation of the Æolus Waterspray and General Ventilating Company, Limited, has no connection with or reference to the business of Mr. Richard Oakley, trading as the Æolus Waterspray, General Ventilating, and Electrical Engineering Company, 235, High Holborn.

**India Rubber and Gutta Percha.**—The proprietor of the *India Rubber, Gutta Percha and Electrical Trades' Journal* has just published, in sheet form, a statistical statement from the official returns of the India Rubber Caoutchouc and Gutta Percha trade of Great Britain during the last decade, giving full details as to imports, exports and values.

**Extracting Metal by Electricity.**—We have been favoured with further particulars as to the process adopted by the Electro Metal Extracting Company for the deposition of pure metal from waste tin cuttings. In reply to the query at the close of our leading article of last week we are assured that the tin is deposited pure, and not in the form of an oxide, and the analysis showing the purity of the tin as deposited to be 99·2 per cent., bears the well-known names of Johnson, Matther & Co. The process evidently possesses some novel points about which we shall have more to say on a future occasion, after a personal inspection of the works which are now in process of completion for carrying on operations on a business scale. The company expects that the process of galvanising, or the process they substitute for galvanising, will be quite as important, commercially, as that of extracting the tin from scrap, and the makers of hollow ware wire and other things are taking great interest in the matter.

**Primary Battery Tests.**—In his communication to us last week Mr. Sydney F. Walker says :—"The results given by M. Hospitalier of the tests of Mr. Schanschieff's battery are certainly very good, but they have been exceeded by a bichromate battery invented by Mr. Maquay, which I had the pleasure of testing some months back in London." Mr. Walker then proceeds to give some figures to show that the results obtained far exceeded in many points anything that had previously been done, or thought possible, with primary batteries. We do not quite see how the figures given support our correspondent's statement. After 6 hours the current reading had fallen nearly 20 per cent. Whereas Mr. Schanschieff's results show that both E.M.F. and current remained constant during that period. Mr. Walker's tests, in fact, do not appear to us to be by any means conclusive as they are but half completed. In the second test made it may also have happened that the voltmeter was not sufficiently sensitive to follow the fall of E.M.F.

**A New Method of Calculating the Candle-power of Arc Lamps.**—A correspondent vouches for the accuracy of the following :—The electrician of a steamship company, on one of whose vessels it was proposed to place an arc lamp requiring a 25 ampère current, calculated the luminosity of the lamp thus. Since an Edison 16 candle-power lamp requires 1 ampère, it follows that 25 of these lamps would equal in lighting power an arc lamp requiring 25 ampères. The latter would therefore give a light of say 400 candle-power.

**Electrical Measuring Instruments.** — Mr. Huber writes :—"Still more charming as the set of apparatus employed to guide the attendant who has to charge the accumulators for the electrical traction at Hamburg, as mentioned in your issue of June 25th, page 602, is the idea of your correspondent that the Julien system of electrical traction might be affected by the indications of electrical measuring instruments. Really it is the best way to misguide your readers in taking out of the articles of your contemporaries only a few lines, and to translate them wrong."

**Deserved Promotion.**—Mr. W. Moon, late telegraphist at TS, and author of several scientific articles which have appeared in the ELECTRICAL REVIEW, has, we learn from the *Telegraphist*, been promoted. He is now located at Llanfairpwl Relay Station, Anglesey.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Telephone Company of Austria, Limited.**—A resolution passed at a meeting of this company held on the 17th June, and registered on the 26th June, authorises the increase of the capital of the company by £100,000 in £5 shares beyond the registered capital of £100,000.

**Bradford Mutual Electric Lighting Company, Limited.**—The registered office of this company is at 1, Hustlergate, Bradford.

**Swan United Electric Light Company, Limited.**—The annual return of this company made up to the 6th April was filed on the 23rd June. The nominal capital is £1,000,000 in £5 shares. Upon 80,004 shares, £3 10s. per share has been called, and 19,750 are fully paid. The total amount of the calls paid on existing shares is £378,262, leaving £824 10s. 0d. unpaid. The sum of £365 has been paid upon 146 shares forfeited.

**Simplex Electrical Syndicate, Limited.**—The statutory return of this company made up to the 21st June was filed on the 28th June. The nominal capital is £6,000 in 120 shares of £50 each, the whole of which have been allotted and are fully paid. Registered office, 109, Farringdon Road.

## CITY NOTES, REPORTS, MEETINGS, &c.

### Australasian Electric Light, Power and Storage Company, Limited.

AN extraordinary general meeting of this company was held on Monday at the offices, Coleman Street, Mr. Benjamin H. Van Tromp presiding.

The Chairman moved the confirmation of the resolutions passed at the meeting on the 11th ult. approving an indenture, dated May 20th, made between the Edison Indian and Colonial Electric Company of the first part, Thomas Alva Edison, of Menlo Park, New Jersey, United States of America, electrical engineer, of the second part, and the company of the third part. The effect of the indenture is to amalgamate the company with the Edison Indian and Colonial Company. The Chairman stated that the arrangement had been approved at a meeting of the Edison Company, and he had no doubt that it would be confirmed by that company. The directors of the Australasian Company would do all in their power to make the arrangement a profitable one for the shareholders.

Mr. J. J. Cater seconded the confirmation of the resolutions, which was agreed to.

### United Telephone Company, Limited.

THE report of the directors for the year ending 30th April, gives the following particulars :—A reference to the capital account will show that up to the 30th April, 1886, the sum of £186,666 14s. has been expended upon the works in connection with the Metropolitan District and instruments on royalty in the Metropolitan District and Subsidiary Companies; being £25,799 18s. 8d. more than the outlay shown in the last balance sheet.

The revenue accounts show that the receipts of the company from all sources properly attributable to the year have been £122,283 15s. 1d., as against £103,000 8s. 4d. in the preceding year, or an increase of £19,283 6s. 9d., and the expenditure has been £54,681 6s. 1d., as against £46,408 6s. 1d., or an increase of £8,273.

The working expenses (Metropolitan District) for the year have been £32,548 4s. 8d., as against £30,172 19s. 7d. for the preceding year, or an increase of £2,375 5s. 1d.

The balance of net revenue account is £70,276 17s. 3d., of which amount the sum of £17,711 19s. 7d. has been absorbed by the payment of an interim dividend at the rate of 8 per cent. per annum for the first half-year ending 31st October, 1885, and the directors recommend a further dividend of 9s. per fully paid £5 share (part paid shares receiving in proportion) for the second half-year ending 30th April, 1886, amounting to £40,279 19s., making a total dividend of 13 per cent. for the year. The directors also propose to carry £10,000 to reserve, leaving a balance of £2,284 18s. 8d. to be carried forward.

A sum of £2,753 9s. 11d., representing profits derived from exceptional sources, has been carried direct to the reserve fund, in addition to the amount set aside for depreciation.

The directors have, subject to confirmation by the shareholders, elected Mr. E. Dwyer Gray, M.P., to a seat on the board. The shareholders will be asked at the general meeting to confirm the appointment. Mr. Dillwyn Parrish, and Mr. W. Cuthbert Quilter, M.P., retire by rotation, and, being eligible, offer themselves for re-election.

**The Eastern Telegraph Company, Limited.**—This company announces that, subject to the final audit, the accounts show, after placing £70,000 to reserve fund, a balance available for dividend sufficient to pay the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, and a final dividend of 2s. 6d. per share with a bonus of 1s. per share, tax free, on the ordinary shares, making, with previous payments on account, a total dividend of 6 per cent. on those shares for the year ending March 31st, 1886, carrying forward a balance of about £4,000.

**The Eastern and South African Telegraph Company, Limited.**—This company notifies that the coupons on the Five per Cent. Mortgage Debentures, due on July 1st, will be paid at the banking house of Messrs. Barclay, Bevan and Company, 54, Lombard Street, London, E.C.

**Globe Telegraph and Trust Company, Limited.**—Application has been made to the Stock Exchange Committee for a quotation in a further issue of 2,000 preference and 2,000 ordinary shares of this company.

**Great Northern Telegraph Company, Limited.**—A half-yearly interim dividend, at the rate of 5 per cent. per annum, will be paid by Messrs. C. I. Hambro and Son, 70, Old Broad Street, E.C.

**The West Coast of America Telegraph Company, Limited.**—The coupons due the 30th ult. on the Debentures of this company will be paid by Messrs. Barclay, Bevan and Company. The coupons must be left three clear days for examination.

## TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 25th were £2,049, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending June 25th were £2,661.

## NEW PATENTS—1886.

8303. "Electric cables." S. F. Shelbourne. Dated June 23.

8323. "Applying electricity to drilling and boring." R. Richards, H. R. Landon, W. T. W. Thackeray. Dated June 23.

8338. "Construction and induction apparatus." L. Gutmann. Dated June 24.

8346. "Dynamo-electric machines." A. B. Blackburn. Dated June 24.

8355. "Armature for dynamo-electric machines." C. E. L. Brown. Dated June 24.

8376. "Clark standards for electromotive force and other galvanic cells having mercury electrodes." A. Muirhead. Dated June 25. (*Complete.*)

8379. "Secondary batteries or electrical accumulators." A. Reckenzaun. Dated June 25.

8395. "Electrical apparatus for taking marine soundings." O. E. Woodhouse, F. L. Rawson, C. S. Snell. Dated June 25.

8412. "Apparatus for transferring cash from one part to another part of a shop or other building, &c." H. H. Lake. (Communicated by the Kenny Electrical Cash Carrier Company.) Dated June 25.

8413. "Incandescent electric lamps." J. G. Lorrain. Dated June 25.

8419. "Making needle-speaking telegraph instruments semi-acoustic." E. Dunn. Dated June 26.

8452. "Electrolytic treatment of certain double chlorides." E. Furst. Dated June 29.

8471. "Electric lamps." H. W. Rhoads. Dated June 28.

8475. "Electric fire alarms." M. A. and H. A. Israel. Dated June 28.

8497. "Apparatus for generating and utilising electricity." A. F. St. George. Dated June 29.

8501. "Portable galvanic batteries." W. L. Gates. Dated June 29. (*Complete.*)

8505. "Electrical switches." C. M. Dorman. Dated June 29.

8513. "Making carbon filaments or other conductors for incandescent electric lamps." W. Maxwell. Dated June 29.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

7616. "Improvements in electro-magneto motors." G. Cumberpatch. (Communicated from abroad by Messieurs. Recordon and Company, of Geneva.) Dated June 23. 8d. This invention is based on the adaptation of the "Recordon electro-magnet" (patent No. 4800, A.D. 1883), to sewing machines, knitting machines, and other small apparatus, the motion being derived from the attractive power the electro-magnet has upon an armature. The improvement in this apparatus consists of a projecting lip or elongation of one of the poles of the electro-magnet, by which means the intensity of attraction during the motion of the armature towards the poles is equalised.

8525. "Improvements in telegraphic signalling apparatus." Luis de Moraes Gomes Ferreira. Dated July 14. 1s. 1d. The inventor employs a single dial and a set of contact studs or buttons arranged after the manner of the Wheatstone machine, or in such manner that the pushing in of one stud to make contact will ensure the breaking contact of all the other studs, and he combines therewith a battery or other source of electricity of any suitable kind. The invention relates more particularly to the construction and arrangement of the mechanism for imparting the step-by-step movement to the pointer of the transmitting instrument, whereby the operator has merely to press in the stud or button corresponding to the letter or signal he desires to transmit, and does not require to move the pointer round, either directly by turning it with his hand, or indirectly by the turning of the magneto-electric machine.

8808. "Improvements in the application of electricity to the treatment of vegetable fibre for the production of half stuff." W. B. Nation. Dated July 21. 4d. The inventor places the raw material in tanks, such tanks being in some cases covered, and in other cases more or less uncovered, according to the character of the materials. The covers are used to convey the gases generated to another part, or other parts of the tank or tanks, or to other apparatus. In the tanks he places a solution of alkaline salt, or a combination of salts. He applies currents of electricity to the ingredients by means of carbons or other suitable electrodes, immersed in the mixture, whereby the salts are decomposed and organically changed.

8881. "Improvements in secondary batteries, part of which is applicable to primary batteries." W. P. Thompson. (Communicated from abroad by E. Julien, of Brussels.) Dated July 23. 8d. The invention comprises three principal improvements, which are preferably employed simultaneously, but which may also be used separately, namely: *a*, the composition of the plate supports; *b*, the arrangement of these plates; *c*, the composition of the conducting fluid. To obtain plates or supports which will not oxidise, an alloy of lead, antimony, and mercury is made use of. A suitable mixture is:—Lead, 96 parts by weight; antimony, 3 parts by weight; mercury, 1 part by weight. As insulators for maintaining the plates at the required distance from each other, buttons of ebonite caoutchouc or other suitable material are made use of, attached to one of the plates, or else by caoutchouc rings surrounding the plate. For joining the plates of the same kind in an accumulator, the usual formation of sulphate at this point is avoided by using wires covered with gutta percha and connected to a common terminal. The solution consists of sulphuric acid and water, with a proportion of peroxide of hydrogen, $H_2 O_2$, added.

## CORRESPONDENCE.

### The Upward Battery.

I shall have much pleasure in answering Mr. Walker's letter in next week's issue. I have been waiting for Dr. Oliver Lodge's official and final report which is just received, and is most favourable; so that in answering letters of this kind my statements will be verified by the most eminent specialist in this branch of science who has critically and minutely examined the whole apparatus both in practice and in theory.

**A. Réné Upward.**

*June* 30*th*, 1886.

### Primary Batteries.

At various dates during the last few years I have had several different types of primary batteries to test and report on. I am therefore interested in the correspondence on the subject started in your columns.

In your issue of June 7th 1·4 is given as the E.M.F. of a Schanschieff element, but is this standing simply measured through a high resistance potential indicator or when giving a current, and if so what current? The E.M.F. of primary batteries standing and when giving useful heavy currents are very different things.

The most remarkable statement in recent correspondence on this subject is that of Mr. Goldner. In the American *Electrical Review*, June 5th, he gives the E.M.F. of a Volta-Pavia cell at 2·2 volts when giving 28 ampères. I have recently had occasion to look closely at the performance of Volta-Pavia batteries, and I shall have the pleasure of submitting further remarks to you shortly.

**Radcliffe Ward.**

### Claims of a Telephone Company.

In reference to a paragraph on page 553 of your issue of 11th instant, headed "Oriental Telephone Company's Claim for Royalty," I am instructed to say that this Company claims all rights under the Edison patents for the Australian Colonies, and, further, that the directors have under consideration what means shall be taken to prevent infringement of my company's rights.

**A. B. Chalmers,** *Secretary.*

Oriental Telephone Co., Limited,
London, *June 24th.*

### Long Distance Telephony.

I wish to protest against some remarks of my friend W. H. Preece, and the conclusions to be drawn therefrom relative to long line telephony. This company has, within Wisconsin, over 2,500 miles of "toll lines," connecting exchanges with each other. The majority of these lines radiate, naturally, from Milwaukee, the largest city of the State.

We have no lines with two wires, *i.e.*, metallic circuits or loops. All are single wires. Yet our patrons converse daily with points 150 miles away, without difficulty, except on stormy days. Our latest built lines are of No. 12 B.W.G. hard-drawn copper wire. By avoiding all railways and all highways, upon which telegraph lines are built, and crossing all such lines at right angles, we avoid induction interferences, and are only troubled by atmospheric disturbances.

Another point, and a vital one, we have found to assist us much. While conversation is being carried on between any two points, the only coils in circuit are those of the talking parties. All call bells and annunciator magnets are "cut-out" from the circuit, so that the line is absolutely clear from interference in that respect. Our experiments prove that the introduction into a clear working, long line, of the coils of a magneto bell, or even of an extra hand telephone, will weaken very much the strength of the current.

I think all American telephone experts will endorse my statements that nowhere, in their experience, are telephone long lines as perfect as in Wisconsin; and I cordially invite all of our English brothers, when they visit America, to come and test, for themselves.

As for the Newcastle exchange, I will cheerfully compare Milwaukee with it; and let Mr. Preece be the judge. This exchange has over 1,500 subscribers on over 1,300 wires. Our record shows over 7,000 calls answered every week-day. The average time consumed, from the subscriber's call until his want is ascertained and the desired party called, is, by actual record, *only four and one-fourth seconds.* Investigation is invited upon this point also.

I send herewith our latest directory for Milwaukee and those other exchanges that are connected by toll lines with Milwaukee.

**C. H. Haskins.**

Wisconsin Telephone Company,
Milwaukee, *June 15th*, 1886.

### Mr. Campbell-Swinton's Book.

In your review of my little book, "Elementary Principles of Electric Lighting," published in your issue for yesterday you make the mistake of confusing the table of contents with the list of illustrations.

The book is really divided as follows:—The nature of electricity; electrical measurements; galvanic batteries; magnetism and electro-magnetism; magneto-electricity; dynamo-electric machines; electric lamps; electric lighting installations; electric accumulators.

I shall feel obliged if you will correct this in your next issue.

**A. A. Campbell-Swinton.**

Newcastle-on-Tyne,
*June 26th*, 1886.

### Inter-Communications in Trains.

The reason that I suggested three wires (or two and the rails) in my letter of last week was that a second bell—which I omitted— might be rung in the guard's van.

**J. D. Leech.**

*June 26th*, 1886.

### The Knock-Over Switch.

My attention has been drawn to your description of this apparatus in the REVIEW of June 18th, in which my name is inadvertently omitted as joint patentee with Messrs. Goolden and Trotter. You were good enough to illustrate my original form of automatic cut-out and switch last year in your account of the Globe Electrical Company's exhibit at the Inventions Exhibition, and the knock-over is Mr. Trotter's ingenious adaptation of my principle, and can be thoroughly recommended for temporary installations; but for a permanency a fusible cut-out will, in my opinion, always be found the most reliable after a long period of inactivity.

**Killingworth Hedges.**

Westminster, *June 28th*, 1886.

### Electricity v. Heat.

Enclosed you have copies of two letters. It is for you to judge how far their contents may be suitable for the pages of the ELECTRICAL REVIEW. In sending you them I have discharged my duty towards the science of electricity.

**James Johnstone.**

Electrical Laboratory,
8, Dalhousie Terrace, Edinburgh,
*June 28th*, 1886.

[COPY.]

8, Merchiston Park, Edinburgh,
*25th May*, 1886.

Dear Sir,—By this post I send you three copies of the ELECTRICAL REVIEW and five copies of the *Electrician*. In the ELECTRICAL REVIEW of 16th April, page 356, you will find a reprint of the letter which you addressed to the editor of the *Electrician and Electrical Engineer* about Mr. J. G. White's experiments, and on page 357 of the same No. of the ELECTRICAL REVIEW you will find remarks made by the Editor of that journal about the contents of your letter. According to my reading of your letter, the Editor of the ELECTRICAL REVIEW has misunderstood your writings about Mr. White's experiments. I understand you to write that Mr. White found that to insulate or clothe a wire was a means of keeping it cool, while the unclothed portion of it became heated. On the other hand, Mr. Sabine found by his experiments that to insulate or clothe a wire was a means of keeping it hot, while the unclothed part remained cool. These two men's results being diametrically opposed to one another, and yet the Editor of the ELECTRICAL REVIEW has, in repeated notices, appended to my letters, page 434 and 460, maintained that the results of these men's experiments are the same.

I will take it as a very great kindness if you would let me know if the details of Mr. White's experiments have been published, and if so, where. If they have not been published, and you are at liberty to give any more information about them bearing on this dispute, I would be glad to receive it.

The five copies of the *Electrician* sent contain letters of mine which may interest you. On page 11 of the No. for 14th May you will observe a letter signed " A Reader," who makes the same mistake in supposing that Mr. Sabine's and Mr. White's experiments were identical in their results.

Yours faithfully,
(Signed) JAMES JOHNSTONE.

Prof. Anthony, Physical Section,
Cornell University, U.S.A.

Department of Physics, Cornell University,
Ithaca, N.Y., *June* 15*th*, 1886.

James Johnstone.

Dear Sir,—In answer to yours of the 25th May, I would say that in all cases the covered wire kept cooler than the naked. I shall soon publish the results of Mr. White's experiments complete in the *Electrician and Electrical Engineer* of New York.

Yours very truly,
(Signed) WM. A. ANTHONY.

[We insert these letters in the hope that our reply may come under the notice of Professor Anthony. Naturally in all cases the covered wire kept cooler, as Robert Sabine showed years ago, and we think it would have been a gracious act on the part of Prof. Anthony to have set Mr. Johnstone clear on this point, for he, at least, must see that which we have so unsuccessfully endeavoured to set before the distorted vision of our correspondent.—EDS. ELEC. REV.]

## Constant Currents for Electric Lighting.

There has been quite a little breeze of discussion lately about the above, so perhaps I may be permitted to add a line on the subject, as there is one view of it, a non-scientific but, I believe, very practical one which I do not see anybody suggest. We have a never-ending succession of new mechanical governors for steam engines and all sorts of new fangled elaborations in the shape of electrical governors, while at the same time, as it seems to me, electrical engineers are neglecting more and more the very simple means at their disposal for helping to produce regularity of running. I refer to two things, heavy flywheels and long heavy belts.

In the earlier installations, even where counter-shafting was employed, these were never neglected, with the general result, judging from what I have seen, that these installations run much more smoothly and with much less trouble as to irregular speed and breaking of straps than the more modern ones.

Economy of space is no doubt a great thing *where space is valuable*, but there has been so much effort in this direction caused by the need of small engines and dynamos for torpedo boats, trains, and the like, that engineers are getting to take it as a matter of course that for a good installation the dynamo must of necessity be somewhere within arm's length of the engine or thereabouts. No one that has not actually had experience of both can tell how much difference is made by a long heavy belt and a really heavy flywheel. Most of the flywheels that I see on engines for dynamo driving are little better than big pulleys, and the straps are too often as rigid as bars of iron. Where the belt approaches the perpendicular (as sometimes in the second belt of counter-shafting) or is at any angle greater than say 30° from the horizontal, this may, to a certain extent, be inevitable to avoid slip on the rigger of the dynamo, but there is no need for it on horizontal or nearly horizontal belts, while I can say without hesitation that very tight belts are as a rule a source of endless trouble, while they have the double disadvantage of wearing away the armature bearings very fast at one particular part, and communicating to the machine and consequently to the light, every variation, however small, in the speed of the engine. Good governors will do a good deal, but the best will not do everything. I remember a recently-erected installation of about 700 lights, Marshall's semi-portable engine and Edison-Hopkinson dynamo, where the engine-house was built specially for the purpose in the middle of an open field, and the contracting electrician could, for the asking, have had it three times the length, but the dynamos (it is a twin installation) are so close that one can stand between the condenser of the engine and the machine and rest a hand on each. The belting (direct driving) is that best of all sorts for taking up variations in speed, the link leather and heavy, about 10 inches, but the space between the flywheel, which is used for driving, and the rigger, is so short (only about 18 feet, if as much) that the most watchful care is necessary on the part of the stroker to avoid actual disagreeability of variation, and the absolute steadiness that incandescent lamps should possess is practically an impossibility.

On one occasion the electrician in charge desiring particular regularity of speed for that night, determined to himself drive and stoke, and gave the stoker a temporary holiday, and he found that in spite of the very good governors (Marshall's own) it was a matter of firing in spoonsful, and about every two minutes and incessant opening and closing of doors, windows, and dampers, to keep a regular light, for the governors naturally would not do everything, and the sensitive character of a multitubular boiler combined with a small light flywheel and short tight belt, necessitated such unremitting watchfulness as no ordinary stoker could be depended on to give.

Now for the converse. At a mill not very far from Coventry there is running an electric light installation, put up by the manufacturer himself, who is an amateur electrician. The engine is an old multitubular portable on wheels (chocked down and chained) and when started was in anything but good condition, having had long and hard usage on a farm and a builder's works and elsewhere.

The flywheel was very small and light, and the governors old fashioned and clumsy to the last degree —a couple of ponderous balls on long arms; indeed, they were quite useless for electric lighting purposes. The dynamo was a good machine, a "Phœnix" of Paterson and Cooper, but no compound winding or any sort of compensating arrangement like the others I have mentioned had. The strap was pieced together of about a dozen different sections of leather, and Gandy's, and other sorts, quite a patchwork affair, but the joints were all evenly and carefully made. The belt was only about 6-inch and therefore not particularly heavy; but there was one strong point in the whole, the machine was 60 feet or more away from the engine; indeed, it had to be elevated on a special timber structure to enable the belt to run clear of the ground, and the latter, the strap, was arranged to be just as loose as it could possibly be without the top section dragging on the under one. The result was and is, one of the steadiest lights I know of. The belt which runs between two or three pairs of guides, is perpetually on the swing, sometimes almost flapping, but it binds perfectly on the rigger of the dynamo, and the driver has sufficient leisure to do a variety of odd jobs, while firing up only once in a quarter of an hour or so.

Compare these two installations: on the one hand, admirable engines, the heaviest belting made and the best dynamos that money could buy, compound wound, but an unsteady light, and great trouble to prevent its varying to an absolutely worrying degree; on the other hand, a rattletrap engine of the same general kind, multitubular portable, on wheels, with useless governors and a dynamo not compound wound, but a very long and loose belt, and a steady light with little trouble.

Nor is it necessary to have a tight belt in order to transmit a considerable power. In one of the largest installations I know, that of the Manchester Edison

Company at Manchester, nearly 140 H.P. (keeping up about 800 lights) is transmitted by link-leather belting so loose that the top sections almost touch the lower as they run, and no great length either between engine, flywheel and dynamo pulley—only about 20 feet, if as much—but the belting is broad and consequently heavy, of a heavy kind, while the flywheels are very massive. The driving is, of course, direct off the flywheels (each of which carries two belts; the installation like the first I mentioned being a twin set of engines and four dynamos, so that each belt carries 70 H.P.), and so well have the loose belts worked, that in now nearly four years' running, the light has never failed for an instant, save once in the beginning when a man-hole cover blew off a boiler and it took three-quarters of an hour to disconnect, repair damages and go on with the other boilers. I believe, too, that the bearings of the armatures are the original ones, and though there is no countershaft, the light is perfectly steady, while had it been a case of the rigidly tight belts so often seen now, the annals of the installation would have been disfigured by the record of a broken strap and its results.

There are a number of large mills round Manchester lit with the electric light, and in more than one of these there are striking examples of irregular speed occasioned by badly-constructed engines or defective governors or similar causes being overcome by a long slack belt, the span in one case being nearly 50 feet each way, the belt being horizontal and up in the ceiling, forming a first countershafting belt. At another mill at Leicester where the dynamo was arranged to drive by a vertical belt off countershafting, much trouble was caused on the putting up of the installation by the fact that the main countershaft, which was very long, and driven from the engine at one end, had a decided spring in it, which communicated itself to the light, but I have since been informed that this has been entirely obviated by shifting the position of the dynamo and using a long belt.

I heard also that at Mather and Platt's, after much trouble, and changing of governors, &c., to make a small engine give a perfectly constant speed on the pulley of a dynamo, the evil was cured at once by shifting the relative positions and using as long and heavy a belt as was practicable.

I could multiply instances of this sort, and others of increasing the weight of flywheels by attaching masses of lead or iron to the limbs, with a most beneficial effect, but space forbids. I may, however, mention the case of the gas engine, which is coming so much into use. The great difficulty with this is to secure regularity of impulse, and this has hitherto restricted the gas engine almost entirely so far as electric lighting is concerned to the charging of accumulators; but if a heavy flywheel, or one made heavy by weighting, be employed, together with even a direct-driving strap, provided this be long, and as slack and heavy as practicable, a gas engine can be made to drive a dynamo as well and as steadily as any other sort of motor. I know several cases of gas engines of the larger sizes driving dynamos with perfect steadiness by the interposition of counter-shafting and long belts with only the ordinary pair of flywheels supplied by the makers, and one case where a 12 H.P. Otto, by the help of a hundredweight of lead and a long link-leather belt, has been made to drive direct, and keep the lamps as steady as moonlight, although the explosion is only at every second or third stroke.

I can imagine I hear some electrician exclaiming, "Well, this is all stale stuff; we know all this;" but, if so, why do not the electrical fraternity practice it? Unsteady incandescent lamps are to be seen among the London installations to a lamentable extent, and, I know, militate seriously against the adoption of the light in the minds of many civilians. I hear constant comments on the subject. Only the other night I was travelling by the Mansion House, Mark Lane, &c., extension of the Underground Railway, and noticed that the incandescent lamps with which the platforms are lighted were varying to such an extent that the most careless observer could not have failed to notice it; such a light would have given anyone who had to read or write by it a pair of aching eyes in a very short time. The location of the lamps being a railway station, it did not matter so much as a question of utility; but what of the effect produced on the minds of the many wealthy merchants and others who travel by that line?

It ought to be a hint to electrical engineers that at the Indian and Colonial Exhibition the straps are, as a rule, very long; in the case of the main line of countershafting in the electric lighting department, they are made almost as long as space would permit, though I cannot say that they are either heavy or slack. The link-leather belting seems conspicuous by its absence, while in many cases the straps are as taut as bowstrings. Perhaps so much of the incandescent lighting of the place being done by accumulators, coupled with the great preponderance of the arc lamps, has made the constructors to a certain extent indifferent to exact regularity of speed, as I know an opinion obtains among many electricians that constancy of current and regularity of speed do not matter for an arc lamp.

I noticed in one of the northern galleries a beautiful engine of Messrs. Galloway's, driving by two belts off its flywheels a large Brush dynamo and another. There was evidently considerable H.P. going on both, especially the nearer one, and the strap in this case, though a very broad, and (for a leather belt), pretty heavy band, described absolutely straight lines in the air. There was not the slightest appearance of "sag," and I remember involuntarily thinking of the tremendous grind there must be on the pulley bearing of the large machine, and the automatic certainty with which every stroke of the piston would be reproduced on the needle of the ammeter and the light of the arc. It seemed to me also the more curious, as by a little arrangement (apparently) another ten or twelve feet could easily have been gained between engine and dynamo.

However, I have already trespassed too much on your space, and will conclude by urging on all who have the erection of electric light installations to have as great a space between engine and dynamo, and as heavy a flywheel on the former as circumstances will permit, being certain that the use of belts as long and heavy as possible more than repays in the end their greater first cost in the steadiness of their running, the saving of wearing and "firing" in bearings, and the inestimable advantage of avoiding stoppages and breakdowns.

**Edward Conry.**

*June 21st*, 1886.

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### Electrical Measuring Instruments.

Enclosed I beg to hand you a reply to the article, "Electrical Measuring Instruments," published in the last issue of your ELECTRICAL REVIEW, and trust you will be kind enough to reproduce it in your next number.

I profit of this occasion to communicate to you that I am with pleasure ready to give you details about the electrical traction introduced by me here. One car I have running regularly since a month at entire satisfaction, and on a line with very steep inclines; a second car will be ready in a short time.

**J. L. Huber.**

Hamburg, *Jnne 28th*, 1886.

[We have placed our correspondent's reply in our Notes columns. There was nothing erroneously translated, the remarks about the testing instruments being our own. We imagine that Mr. Huber is the only one of our readers who misunderstood us, for surely if either the high or low readings of instruments which vary from 20 to 30 per cent. be taken, the Julian system may be made very economical, or the reverse, according to taste, or perhaps we had better say, as the system is viewed with favour or disfavour.—EDS. ELEC. REV.]

[illegible]

[illegible] "A.B.C." and other Lamps.

Accumulators.

Telegraph Instruments.—[illegible] Telephones, Switch-boards, Magnetos, [illegible] Bells, &c., &c.

[illegible] Dynamos suited for [illegible] Ships, &c.

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**Works: Silvertown, Essex; Persan-Beaumont, France.**

## TELEGRAPH ENGINEERS AND MANUFACTURERS OF

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[illegible] Wheatstone's Alphabetical, Semaphore "Block" Instruments, [illegible] and other Galvanometers, Condensers, Testing Instruments, [illegible]

[illegible] GREAT BRITAIN, IRELAND, AND THE COLONIES [illegible] BATTERY, which has received the most favourable reports from the [illegible] other eminent Telegraph Engineers, and is now in general use by the Post Office [illegible] and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. [illegible] other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

**INSULATORS.**—[illegible], Porcelain, Brownware, &c.

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TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

## TORPEDO APPARATUS.

*THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY (Limited) are Patentees and Manufacturers of a Complete System of Torpedoes for Harbour and Coast Defence,*

AND OF THE

## SILVERTOWN PATENT FIRING BATTERY.

A Constant Battery for Mining and Blasting Purposes.

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VALVES, SHEET, BUFFERS, SPRINGS, WASHERS, WHEEL TYRES, CORD TUBING, AND DOOR AND CARRIAGE MATS.

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## EBONITE.

*Not affected by Vinegar or Hydrochloric or Acetic Acid.*

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| Pumps.<br>Photographic Articles. | Speaking Tubes, Mouthpieces.<br>Battery Cells. | Sheet and Rod.<br>Surgical Appliances. |

## GUTTA-PERCHA.

Tubing, Belting, Buckets, Bosses for Flax Spinning, &c.

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